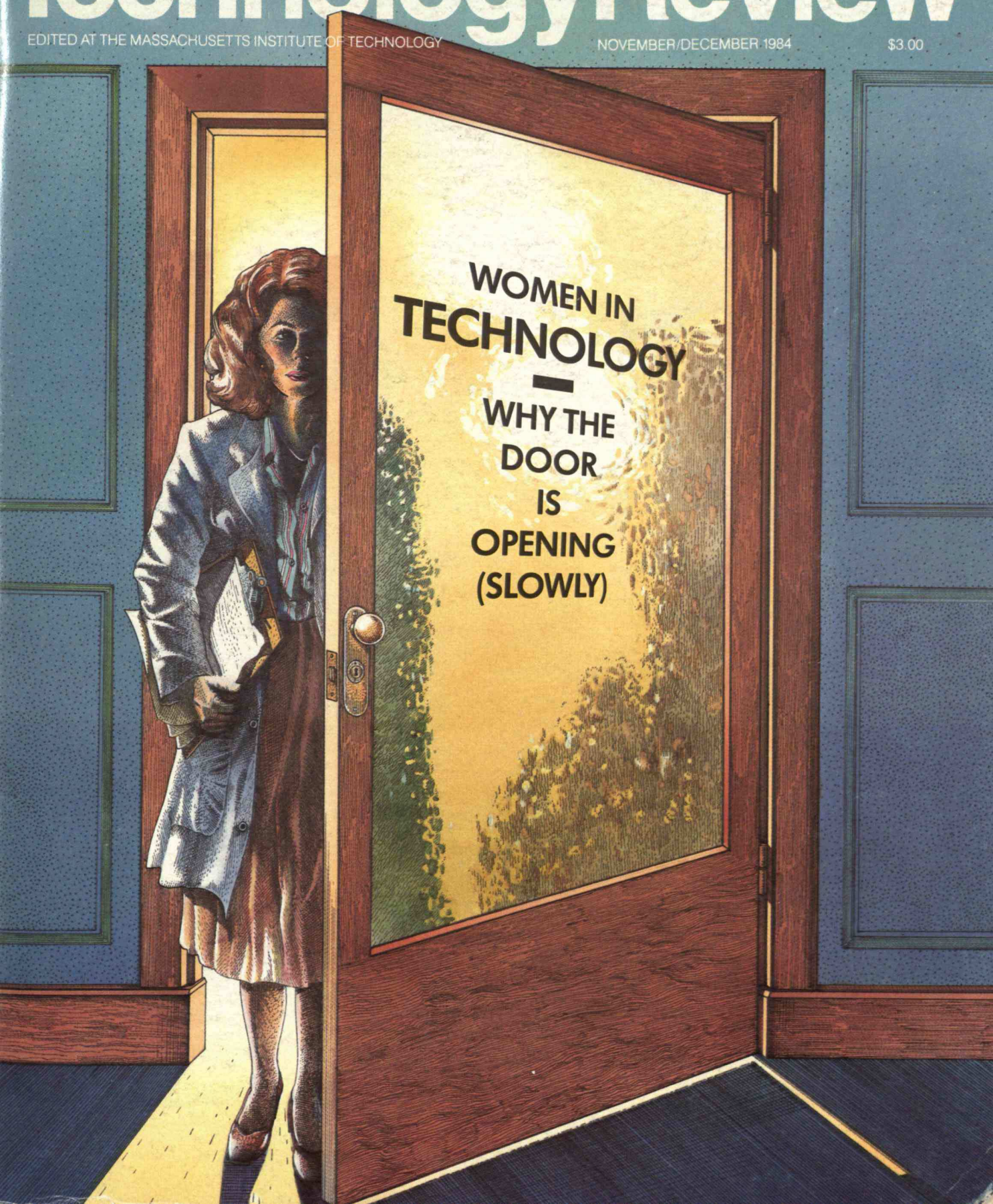
ARTIFICIAL HEART FAILURE ▪ HIGH-TECH COMPETITION FROM SOUTHEAST ASIA

Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

NOVEMBER/DECEMBER 1984

$3.00



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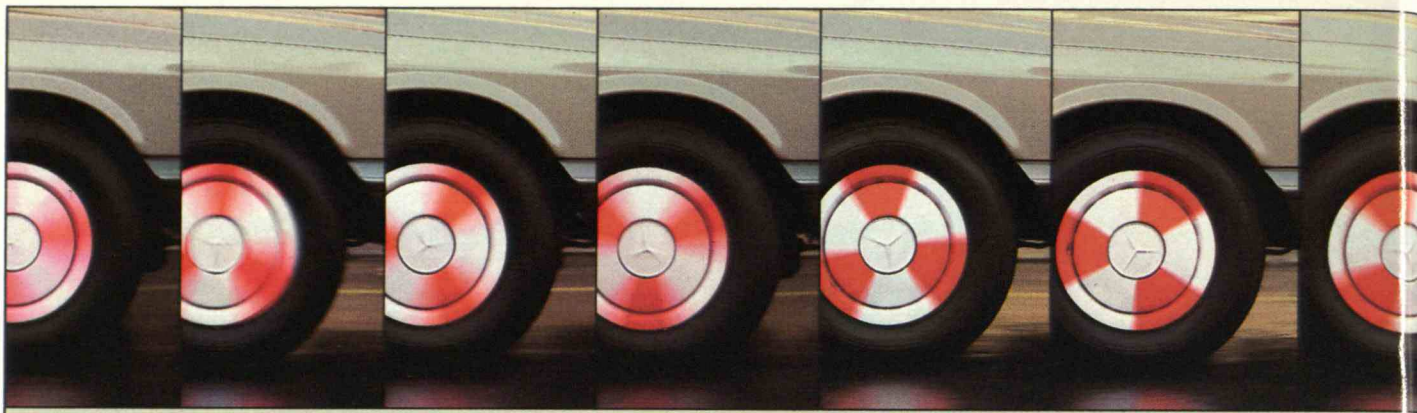


Wet road, hard braking–and within the one-second sequence dramatized above, the Mercedes-Benz Anti-lock Braking System acts to electronica

For 1985, Mercedes-Benz introduces something more important than a new model.

THE MERCEDES-BENZ sedan speeds straight toward a patch of test track slicked down with a diabolical mixture of soapsuds and water.

A splash as the tires meet wet pavement–and then the driver slams on the brakes.

But what seems bound to happen in the next heart-stopping instant, doesn't happen. Violent braking action on that treacherous surface sets off no violent counterreaction.

That Mercedes-Benz sedan simply snubs down to a quick, straight-line stop. Soapsuds and water and all.

THE MERCEDES-BENZ ANTI-LOCK BRAKING SYSTEM COMES TO AMERICA

That Mercedes-Benz sedan has just demonstrated the most emotionally reassuring advance in passenger car braking control since the disc brake.

It is the Mercedes-Benz Anti-lock Braking System, or ABS. And having pioneered both its early development and its subsequent use in production automobiles, Mercedes-Benz now proudly introduces this significant engineering feature to America. It is being fitted as standard equipment to every 1985 Mercedes-Benz 500 SEC Coupe, 500 SEL Sedan, 380 SL Coupe/Roadster, 380 SE Sedan and 300 SD Turbodiesel Sedan, and as an extra-cost option to the 190 E 2.3 and 190 D 2.2 Sedans.

Functioning in concert with the car's four-wheel disc brakes, the Mercedes-Benz Anti-lock Braking System is meant to first sense the impending lockup of one or more of the car's wheels in a sudden braking emergency –then to act, with lightning speed, to avert it.

The benefits are clear. By minimizing the risk of the car's wheels locking up in hard braking, the system can also minimize the potential consequences: the sudden loss of tire adhesion that could turn a steerable vehicle into a sliding object no longer under the driver's full control.

More reassuring still, the system is designed for braking emergencies on slippery-wet roads as on dry roads–indeed, to maintain optimum braking performance almost regardless of road surface conditions.

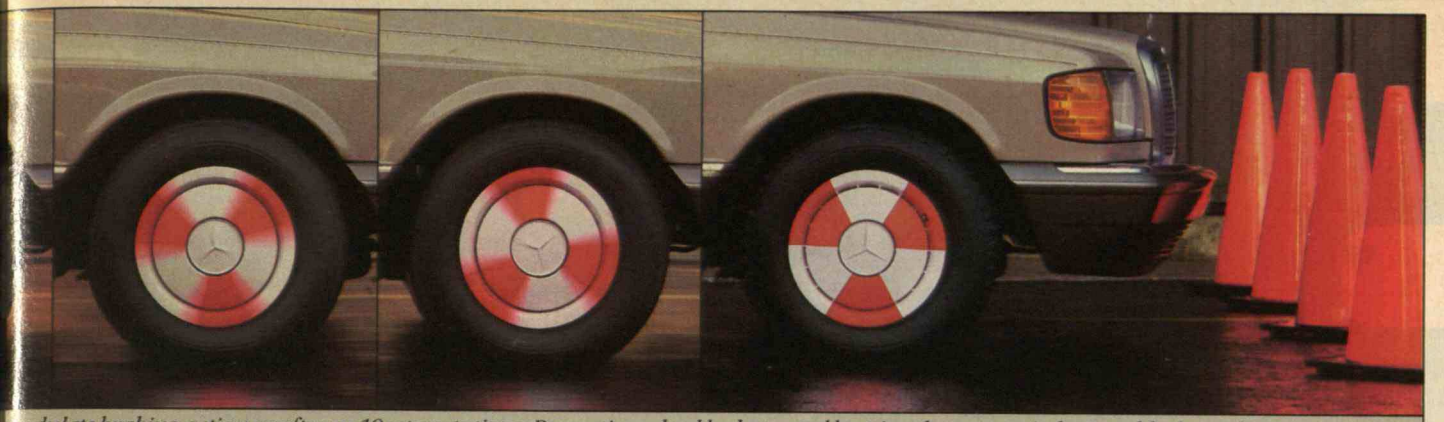
SENSING TROUBLE BEFORE IT BECOMES TROUBLE

The decision-making "brain" of the Mercedes-Benz Anti-lock Braking System is an on-board computer. Electronic sensors, placed at both front wheels and at the drive pinion of the rear axle, are the system's vital nerve ends.

In a moving car under normal driving conditions, those sensors are constantly signaling the rotational speed of the wheels to the computer. Registering a millisecond-by-millisecond electronic bulletin on the precise state of adhesion between the car's tires and the road surface.

Then comes that sudden emergency. The driver reacts to danger ahead by reflexively hitting the brake pedal hard; hard enough, in a conventional braking system, to risk locking up one or more of the car's wheels.

But those electronic sensors



odulate braking action as often as 10 separate times. Preventing wheel lockup–and keeping the car precisely steerable throughout.

have already detected the onset of wheel slip and alerted the computer. And the computer starts regulating fluid pressure in the brake lines. Modulating and cadencing brake pressure, via solenoid valves in the brake lines, as often as *ten times* per second. Countering lockup of all four wheels or any individual wheel.

And thereby allowing the car to be swiftly and smoothly decelerated. Allowing the car to be precisely steered and maneuvered *as* it decelerates. Helping the driver to avoid a collision, or simply to stay on the road.

6,000,000,000 MILES

Mercedes-Benz began development work on the principle of the anti-lock braking system as far back as 1959, first fitted a working system to a production automobile in 1978, and has since seen 250,000 of its cars roll up over *six billion miles* of experience with the system worldwide.

Once again following where Mercedes-Benz has shown the way, some domestic and foreign makers will shortly introduce similar anti-lock braking systems to America. They can emulate the idea. They cannot emulate this depth of experience.

More than 50 percent of the logic circuitry programmed into that on-board computer is safety circuitry: the entire system is designed to be electronically self-checking, constantly monitoring itself and primed to shut down instantly should a malfunction ever be indicated. The car's separate four-wheel disc brake system would, of course, remain fully operational.

In terms of enhancing control of the car in a braking emergency, the Mercedes-Benz Anti-lock Braking System may be the best ally a driver has ever had. In terms of automotive leadership, this major advance underscores the truth of the motto below: for 1985, as for the past 99 years, the automobiles of Mercedes-Benz are indeed engineered like no other cars in the world.

Engineered like no other car in the world

Photography: Peter Read Miller.

How to stop a mid-air collision.

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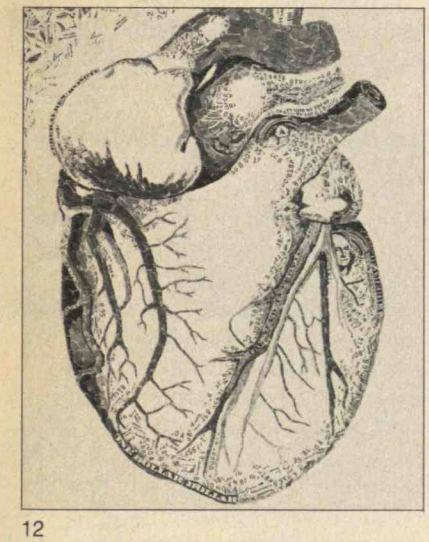
29



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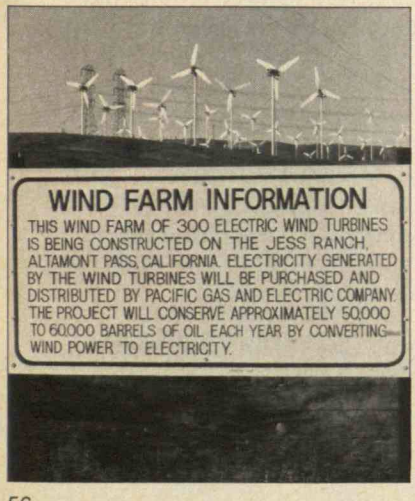

56

Cover illustration by
Roger Leyonmark
Design by Nancy Cahners

Q. WHY ALL THE TALK ABOUT LOCAL AREA NETWORKS?

A. There's been a lot written about Local Area Networks (LANs). What's all the talk about? Why are LANs important? Should your company be looking into them? Is one kind of LAN better than another?

The fact is, a lot of people, ourselves included, think LANs are going to play a key role in the total telecommunications picture for most businesses. Here are some questions and answers that might help you better understand LANs.

Q. To begin with, just what exactly is a Local Area Network (LAN)?

A. It's a system for moving information between devices located on the same premises. Now that calls for some further definitions. By "information," we mean data, voice, text, graphics or image. By "devices," we mean big computers, personal computers or other workstations, printers, telephones, scanners, files, sensors and actuators, and PBXs. By "same premises," we mean office building, manufacturing plant, hospital, campus or other geographically confined area. In short, and quite simplified, a LAN is one way of connecting all these devices to each other.

Q. There seem to be a number of different kinds of LANs. Why the variety?

A. The reason there are different LANs is because different work situations have different needs and different cost considerations. For instance, one type of network is capable of linking different kinds of computers, workstations and other devices throughout a building or campus. This allows for the exchange of information and the sharing of resources and large data bases. Then there's a need for a network specifically designed to interconnect personal computers. There's also the need for a special "industrial" LAN to meet the unique requirements of manufacturing plants. And there may be other networks developed to meet other needs.

Q. What if I want to link all the devices in my building?

A. IBM is developing a way to get all the devices in a building to communicate with each other using established computer and communications architectures. This will allow the mainframe computers, companywide systems, smaller departmental clusters and even individual workstations to interact and share files, applications and peripherals.

We believe this general purpose LAN, utilizing "token-ring" technology, will provide the greatest flexibility and connectivity for different departments, workstations and systems. Other major benefits of this LAN technology will be very high reliability, predictability of performance, and greater overall network management capability.

The token-ring LAN will use the IBM Cabling System as its foundation. Currently being installed, the IBM Cabling System provides the immediate benefits of a common cabling solution for most IBM systems and workstations.

Q. Suppose I only need to connect personal computers?

A. We recently announced an IBM PC Network that allows a department, small company or remote location to interconnect IBM Personal Computers. This low-cost network lets PC users share files and printers, and send messages from one PC to another. The PC Network also lets users access application programs and data bases in larger IBM System/370 computers.

Q. What about a LAN for manufacturing plants?

A. We intend to offer an industrial LAN which will allow factory floor data collection and interconnection of robotic systems, machine tools, numerical processors and industrial computers.

Q. And if I wanted, could I connect these different networks to each other?

A. IBM has announced that its planned token-ring LAN will also act as a "backbone" connecting these different networks. Each network will have the ability to communicate with IBM System/370 host computers and applications.

Q. What if I'm still not sure which way to go?

A. Choosing a LAN is a business decision that will vary from company to company, and from department to department. Remember that LANs are just a portion of your company's overall telecommunications solution—a solution that should be developed in a planned, structured and manageable way. If you'd like some help in figuring out the answer that will best suit your needs today and in the future, call IBM.

There's a lot more to be said about LANs and telecommunications. If you'd like a free copy of "Positioning Local Area Networks," call 1 800 IBM-2468, Ext. 397, or return the coupon.

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☐ Please have an IBM representative call me.
☐ Please send me "Positioning Local Area Networks."

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PUBLISHER
William J. Hecht

EDITOR-IN-CHIEF
John I. Mattill

MANAGING EDITOR
Peter Gwynne

DESIGN DIRECTOR
Nancy L. Cahners

DESIGN/
PRODUCTION MANAGER
Kathleen B. Sayre

SENIOR EDITORS
Alison Bass
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Technology Review (ISSN 0040-1692), Reg. U.S. Patent Office, is published eight times each year (January, February/March, April, May/June, July, August/September, October and November/December) at the Massachusetts Institute of Technology. Two special editions are provided for graduate (pp. A1-A32) and undergraduate (pp. A1-A32 and B1-B24) alumni of M.I.T.

Printed by Lane Press, Burlington, Vt. Second-class postage paid at Boston, Mass. and additional mailing offices. Postmaster: send address change to M.I.T., Room 10-140, Cambridge, Mass. 02139.

Editorial, circulation, and advertising offices: *Technology Review,* Room 10-140, Mass. Institute of Technology, Cambridge, Mass. 02139 (617) 253-8250.

Advertising representatives:
The Leadership Network: 254 Fifth Ave., New York, N.Y. 10001 (212) 684-5500; Benson Co., Park Ridge, Ill.; Colin Smith Agency, Berkeley, Calif.; Joe DeLone & Associates, Wayne, Pa., Fairfield, Conn., Lincoln, Mass.; J. J. Arcisz Co., Boston, Mass.; and McKeldin Co., Atlanta, Ga.
Littel-Murray-Barnhill, 1328 Broadway, New York, N.Y. 10001 (212) 736-1119.

Subscription inquiries and change of address: Room 10-140, M.I.T., Cambridge, Mass. 02139 (617) 253-8292.

Prices:
Single current copies $4 U.S., $5 Canada, $7 foreign. Subscriptions, one year: $24 U.S., $34 Canada, $44 foreign. Back issues available. All prices U.S. funds.
U.S.A. newsstand distribution by Eastern News Distributors, Inc., 111 Eighth Ave., New York, N.Y. 10011.

FIRST LINE

Honored for Design

Technology Review's designers and illustrators have brought new honors to the magazine: four of our entries appear in *Print* magazine's 1983 *Regional Design Annual,* a national juried selection of the year's best U.S. graphic design and illustration. Of 20,000 entries, *Print*'s judges accepted only 1,545.

Our successful entries are covers by Roger Leyonmark (August/September 1983) and William Harsh (February/March 1984), and illustrations by Christopher Bing ("The Myth of Japan, Inc.," July 1983) and Leyonmark ("Measuring the Intangible in Productivity," February/March 1983).

While the role of our illustrators is fairly obvious, the role of *Technology Review*'s designers, who were also cited by *Print*'s jury, is much more subtle and varied. Typical readers of a magazine seldom realize how much its appearance contributes to the mood with which readers approach the articles. Nancy Cahners and

Kathleen Sayre and Nancy Cahners

Kathleen Sayre, *Technology Review*'s design director and design/production manager respectively, have an especially difficult assignment at this magazine: they must set the stage for editors whose goal is to respond to the serious intellectual and aesthetic values of our readers, eschewing both the arbitrary and the sensational.

Cahners and Sayre take special pride in their successful efforts to identify promising young artists just entering the field of magazine illustration. Harsh's *Technology Review* cover was his first published illustration, and Bing's award-winning work was completed while he was finishing art school.

We take with pleasure the opportunity of the *Print* awards to pay tribute, too seldom done, to our designers and illustrators.—*John Mattill*

LETTERS

Mecca in the Making

New Jersey may not have penetrated the high-tech trinity of California, Massachusetts, and North Carolina yet, but I think we're close if the data from the Bureau of Labor Statistics are reliable (*"Building a Mecca for High Technology" by Marshall Goldman, May/June, page 6*). Both northern New Jersey and the corridor south from New Brunswick to Princeton (and beyond) are booming. We are making efforts to improve our universities and retain our graduates as you recommend.

David M. Goodman
Trenton, N.J.

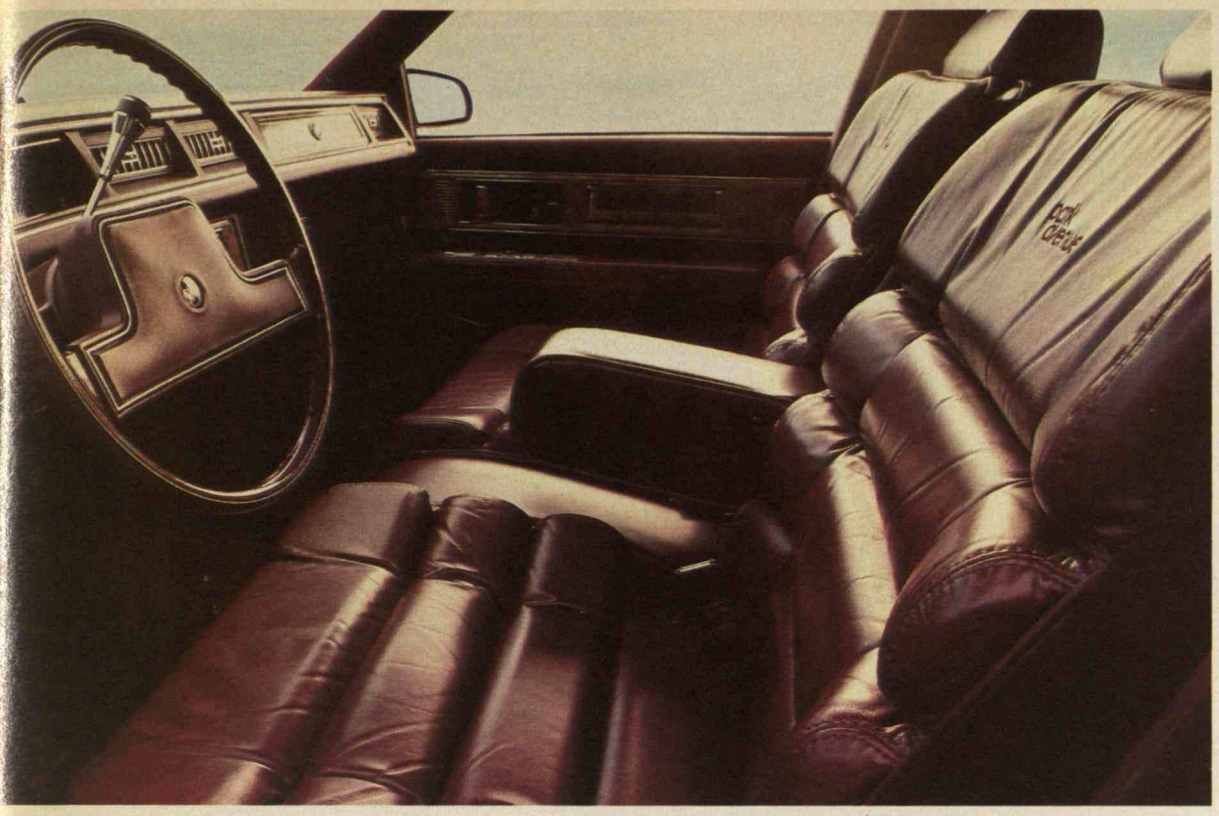
Mr. Goodman is executive secretary of the Governor's Commission on Science and Technology in New Jersey.

Marshall Goldman fails to mention the role of North Carolina State University in the development and support of Research Triangle Park. The park has been successful because of the three (thus triangle) universities doing doctoral-level research within its 16-mile radius, the other two being Duke and the University of North Carolina. North Carolina State has about 37 percent of its 18,000 full-time students enrolled in the School of Engineering.

A recent report by the General Accounting Office in Washington attributes much of the success of Research Triangle Park to North Carolina State. If Mr. Goldman researched the area a bit more thoroughly, he would find a surprising number of young, growing high-tech firms, many of which are owned or headed by graduates of North Carolina State.

The main thing that the Research Triangle lacks is venture capital. But since it is impossible to hide opportunity in the

Continued on page 68



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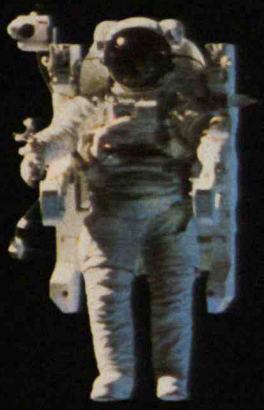

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ROBERT C. COWEN

Scraping the Bottom of the Pork Barrel

AMERICAN universities are suffering a form of poverty that drives some of them to make desperate raids on the federal purse. For more than a decade, federal support for university research has fallen short on funds for new facilities. Now, with urgent needs for new laboratories, some university administrators are bypassing both the peer-review system and the Office of Management and Budget to seek funds directly from Congress.

Does the school need a new chemistry lab? Then have a friendly representative or senator shepherd legislation through Congress that "directs" a federal agency to grant the money. Or, better yet, dip into the endowment for several hundred thousand dollars and hire some Washington consultants such as Schlossberg-Cassidy & Associates, who have pioneered this service, to develop a total lobbying strategy. Either way, funds that no budget planner requested may materialize for projects not subject to independent, objective review.

Such is the academic pork barrel. Although only a few universities have resorted to relying on it so far, this novel scramble for funds threatens the integrity of support for U.S. research. That's why this technique aroused a storm of protest within the academic research establishment when it was first used last year. Indeed, the reaction was so strong as to engender hope of quashing the practice. But for fiscal 1985, the pork-barrel raiders have again brought home the bacon.

By late summer, when Congress wrapped up its business and went campaigning, it had also wrapped up some $21 million of Department of Energy (DOE) grants for favored universities. Don Fuqua (D-Fla.), chairman of the House Committee on Science and Technology, saw to it that DOE was "directed" to award $7 million to Florida State University as a down payment on a supercomputer facility that DOE did not particularly want. The total cost for the facility will probably be around $55 million over 5 years, with DOE picking up 60 to 65 percent of the tab. DOE is also

ROBERT C. COWEN IS SCIENCE EDITOR OF THE CHRISTIAN SCIENCE MONITOR *AND FORMER PRESIDENT OF THE NATIONAL ASSOCIATION OF SCIENCE WRITERS.*

Desperate for new facilities, some universities are subverting the traditional peer-review system.

"directed" to give the University of Oregon $2.3 million for planning a science facility—a project Oregon's Republican Senator Mark Hatfield favors. Catholic University gets $8.9 million to finish a vitreous-state laboratory, for which it received an initial $5 million in last year's pork-barrel deal. And Columbia University—which also got $5 million last year—receives an additional $3 million to continue building new chemistry facilities with an estimated total cost of around $20 million.

The redirection of DOE funds is financed partly by $16 million in cuts from DOE-supported research projects that had been reviewed and approved in open competition. This is exactly the sort of corruption that many academic research leaders fear.

For example, a National Academy of Sciences resolution insists: "Informed peer judgments on the scientific merits of specific proposals in open competition should be a central element in the awarding of all federal funds for science. We urge that the academic community and public officials exercise vigilance to protect this informed evaluation and decision process." Also, the American Association for the Advancement of Science warns that "failure to adhere both in principle and in practice to criteria of scientific choice at all times will serve only to diminish public confidence in the peer-review system as the basis for allocating national resources with serious negative consequences for the integrity and advancement of science." Even the National Association of State Universities and Land Grant Colleges has condemned the trend toward "an irrational system of distribution based solely on political influence," which Florida State's supercomputer deal represents.

Disrepair and Deterioration

Yet leaders of some prominent universities still feel compelled to subvert the system. This tells us something about the state of U.S. research funding in general. The neglect of facilities that has marked federal support for more than a decade is bringing university research to its knees.

Rep. Fuqua himself stated the problem well in hearings last May. "Many of our university laboratories," he said, "are in an alarming state of disrepair and deterioration. They do not provide suitable facilities for modern research. . . . The federal role must be considered . . . if our universities are to continue to produce at their full capacity."

Thus, some university administrators may feel themselves to be like the honest but jobless citizen who, in desperation, robs a store, to feed his family. They may well see a direct appeal to Congress as a lesser evil than having their competence in doing research eroded. And, as Kenneth Schlossberg of Schlossberg-Cassidy has candidly observed, if representatives or senators can help "in a way that isn't obnoxious to them—and even serves the public interest—they're delighted to."

The dangers of pork-barrel funding are serious, but so are the problems of facilities-poor universities. The real need is for concerted action by the academic community and its congressional friends to prepare and implement a remedial program that preserves impartial expert review of project proposals. Merely preaching the gospel of competitive grantsmanship will do little good. The pressures that drive universities to bypass peer review will, if unrelieved, continue to produce an academic pork barrel. □

ILLUSTRATION: EUGENE YELCHIN

BY MARSHALL I. GOLDMAN

Will High Technology Come from Southeast Asia?

As recently as two decades ago, economists were hard put to find even one country that had pulled itself from the ranks of the underdeveloped. Today there are so many that a new category has been created to describe them—NICs, or newly industrialized countries. Such growth has been particularly impressive in Southeast Asia, especially among the "Gang of Four": South Korea, Taiwan, Hong Kong, and Singapore.

These countries' progress has not always been smooth, and their futures are not without hazards. For example, much remains to be resolved about what will happen to Hong Kong after Britain's lease on it expires in 1997. Yet the economies of the Gang of Four continue to show impressive rates of growth, sometimes as high as 10 percent annually. Furthermore, their growth is not, as so often happens, restricted to heavy industry, and this growth is reflected in significantly improved standards of living. Not bad for a region that as recently as the 1950s was, if anything, noted for its economic and political instability.

I could readily see the factors behind these modern economic miracles during a recent visit to the area. The people work hard, the technical literacy essential for industry is widespread, and, except in Hong Kong, income distribution is relatively equitable. The availability of an able and motivated workforce has made it possible for these countries, unlike most other developing nations, to focus on labor-intensive production—initially textiles and increasingly electronics. Because of its low labor costs, the Gang of Four's products sell at extremely competitive prices on the world market.

Production versus Innovation

So far, most of the technology on which these products are based has been imported. Following the Japanese practice, the Gang of Four has tried to improve products but has still accomplished relatively little innovation, especially in high technology. Instead, manufacturers in these countries generally perform the routine tasks required to make products developed in the United States or Japan.

Singapore aims for high-tech production, Taiwan for innovation. Which will be more successful?

Such a derivative status has its limitations. If competition arises in other countries where labor is even cheaper, the Gang of Four will be vulnerable. And manufacturers in some countries such as Taiwan and South Korea want not only to produce sophisticated products but also to invent them—to be originators of high technology, not just assemblers.

Nations must adopt a considerably different strategy to become successful innovators rather than merely successful makers of other countries' products. For example, Singapore has clearly adopted the latter strategy, emphasizing universal high-school and vocational training but offering university education to no more than 8 or 9 percent of the population, according to official figures. In fact, the country has only one university to serve the island's 5 million people; those who are not admitted but still want an education must finance it themselves and go elsewhere.

Singapore officials consciously decided on this strategy and are explicit about their motivation. They concluded that all too often developing countries devote too many resources to university education. Young graduates who remain in the country are underutilized because the developing economy generates little demand for such highly trained specialists, particularly those schooled in the humanities. University graduates therefore become fertile ground for unrest and even revolution. If they leave for the United States or Western Europe, the government has merely financed a brain drain. As long as production jobs await them, the young are better off without fancy training, the theory goes, and the country is better off not providing that training. Should industry need additional scientists, it can import them.

This approach has certainly worked in Singapore so far. But now what? Singapore is already beginning to run into competition from other countries with even cheaper labor for performing some of the routine jobs. This country should therefore presumably be preparing to make products that require more technical sophistication, and hence more engineers and scientists. But because of the government's policies, these specialists are not available now and could hardly be educated in large numbers in less than a decade. Singapore seems to have hamstrung itself for the future.

Fostering Innovation

Taiwan has deliberately taken the opposite approach. About 25 percent of the eligible age group is enrolled in universities there, according to official estimates. Just as predicted by Singapore authorities, Taiwan has had a serious brain drain. However, in an effort to foster the growth of high-technology industries, the government is seeking to bring back some of the Taiwanese scientists and engineers living abroad, particularly in the United States and Hong Kong.

The main attraction is the Tsinchu Science Park located near several universities about 40 miles from Taipei. Those who return to Taiwan and set up their own companies in Tsinchu enjoy big tax

MARSHALL I. GOLDMAN IS PROFESSOR OF ECONOMICS AT WELLESLEY COLLEGE AND ACTING DIRECTOR OF THE RUSSIAN RESEARCH CENTER AT HARVARD UNIVERSITY.

ILLUSTRATION: ROB COLVIN

concessions, and the government is doing everything it can to provide these companies with engineers and well-equipped research facilities. So far, about 40 enterprises are in operation; some are branches of foreign firms but others are operated from Tsinchu itself.

Though Singapore's approach made sense 20 years ago, given the stage of development of the Gang of Four, Taiwan's approach seems more promising for the future.

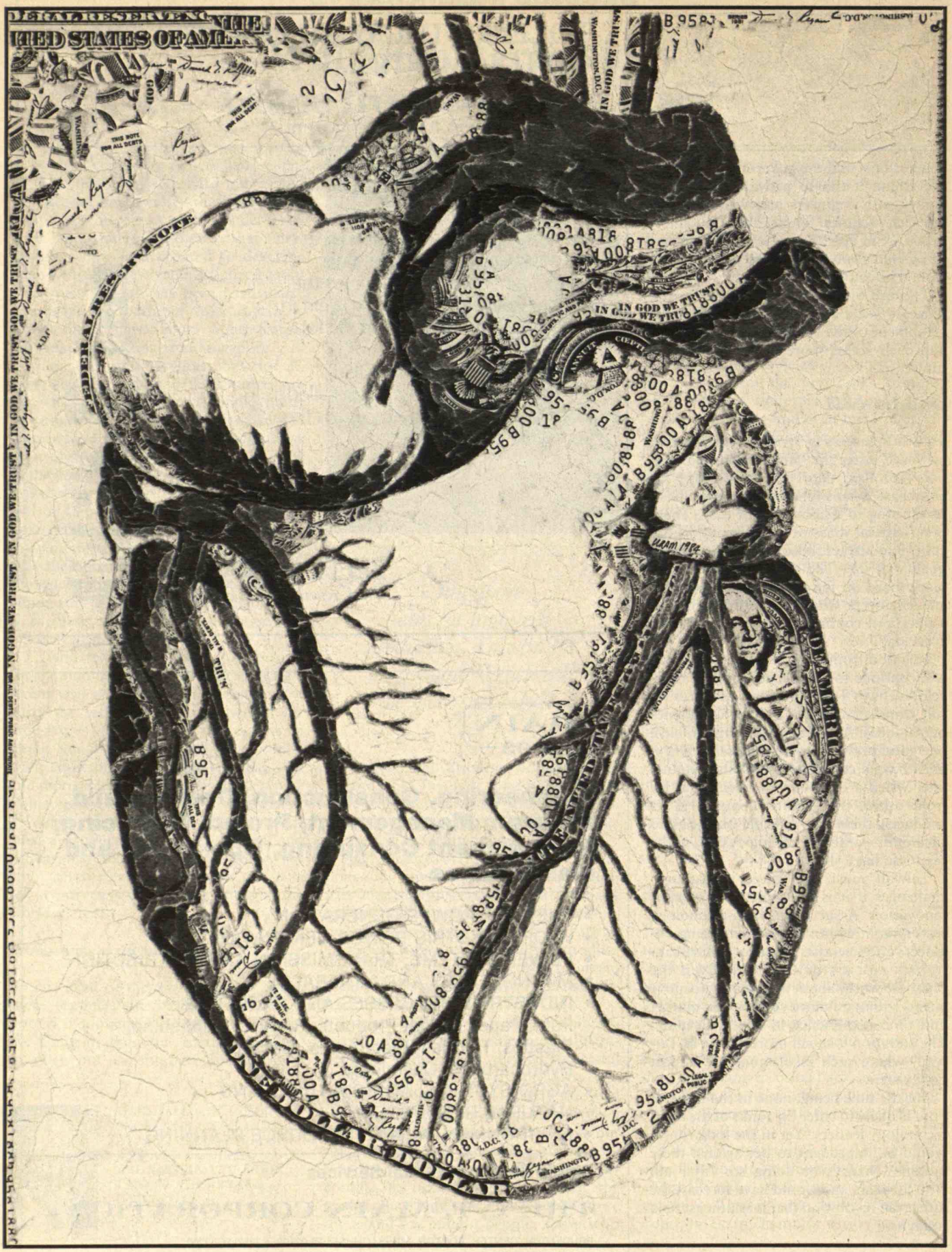
Obstacles Ahead

Taiwan's success is by no means assured, however. After the "intellectual and flesh pots" of Palo Alto and Cambridge (as Southeast Asians tend to see these cities), readjusting to Tsinchu is not easy. There is no critical mass of scientists and little culture to attract those who seek a higher quality of life. The adjustment is particularly hard on the wives. Some scientists and engineers who have returned live in Taipei and commute 40 miles each way every day.

Isolation from today's centers of action will continue to hamper technological development in Taiwan. Many advances result from spinoffs not only of companies but of ideas. And it is not enough to have one good product; to be successful, a firm must have a continually evolving product line. When a company is starting out far from others that use or compete in its products, these are difficult obstacles to surmount—athough not impossible, as the Japanese have shown.

Taiwan must also meet institutional challenges if it is to foster technological innovation. A successful high-technology sector requires not only enterprising engineers and scientists but also venture capitalists and a stock market. Even the Japanese worry about their ability to move ahead without a more viable stock market and more experience in venture capital. The situation is much more severe in Taiwan, where such institutions are almost nonexistent.

For the time being, none of the Gang of Four is likely to enter the ranks of the high-technology leaders. Yet in the long run, it would be imprudent to bet against these nations' chances of doing so. After all, who 30 years ago would have forecast the industrial revolution that is Southeast Asia today? □


IN GOD WE TRUST
IN GOD WE TRUST
DE AMERICA
ONE DOLLAR

Advocates of the artificial heart have relied too much on medical expertise and closed patterns of decision making, overlooking questions of who would benefit and who would pay.

The Misguided Quest for the Artificial Heart

BY BARTON J. BERNSTEIN

THE early 1960s constituted an era of euphoria in which federal funds seemed plentiful, social problems soluble, and scientific triumphs imminent. Money, technology, and prowess, it appeared, would speedily produce any number of medical miracles. Prominent among the expected achievements of medical science was the totally implantable artificial heart (TIAH). The device would fit neatly inside the chest cavity of human patients with major heart problems, giving them much, if not all, of the freedom and flexibility that they possessed when equipped with their own natural, healthy heart.

Biomedical scientists, heart surgeons, and bureaucrats viewed the TIAH as a partial response to the scourge of heart disease, which at that time killed about 700,000 Americans each year. "The artificial heart is feasible now and ripe for development, and it can be effectively achieved," declared a statement by the National Heart Institute (NHI), a federal agency that embarked on the quest to develop a TIAH in 1964.

Today, two decades later, scientists have failed to achieve the lofty goal of a working TIAH. The best the researchers have to show for more than $200 million expenditure is the so-called totally artificial heart implanted just two years ago in retired Seattle dentist Barney Clark. Clark's device gave him minimal freedom; he was tethered by six-foot lines to a 350-pound console that supplied power for the heart. He struggled through 112 painful days linked up to the console before he died—hardly a testament to technology triumphant.

The pursuit of the artificial heart provides an opportunity to examine important themes about biomedicine in particular, and about technology in modern industrial society in general. The quest reflects modern industrial society's great optimism about technology, its emphasis on high-technology solutions in medicine, and its neglect of the so-called "soft" (social, psychological, economic, and ethical) issues. The quest also emphasizes America's great reliance upon technological expertise, its patterns of closed decision making in biomedicine, a lack of congressional scrutiny of ongoing research, and the absence of a public dialogue about a device that raises profound social questions and could add billions of dollars to this country's strained medical budget. On the positive side, it may teach us how to deal better with similar issues in the future.

The Early Enthusiasm

Twenty years ago, technological optimism reigned—along with social naivete. Consider, for example, the reports prepared in 1965-66 by six firms hired by NHI to analyze the need for and feasibility of developing the artificial heart, and particularly the concluding study by a seventh firm. The results, published in 1966, included the following:

☐ How many people would annually need an artificial heart? The consultants reached the specific number of 132,500 by ignoring the incredible estimate of 500,000 to 600,000 by one unusually exuberant contractor (General Dynamics) and roughly averaging the others. One contractor had forecast

ILLUSTRATIONS: LAUREN URAM

Medical experts and their allies in federal agencies have shaped the issues surrounding the artificial heart.

an annual need of about 257,000 hearts and another about 10,000—a range of about 2,500 percent.

☐ How much would an artificial heart cost? A few thousand dollars, based on very optimistic estimates. Since the operation to implant the heart and the ensuing medical care would cost a few thousand more, the total would reach about $10,000 per patient. The consultants did not anticipate that, like Barney Clark, patients might linger in intensive care for months.

☐ How many artificial heart recipients would live and lead normal lives? In the official set of assumptions, nobody died on the operating table. Rather, all recipients of the TIAH would return to normal life and, on the average, live longer and more healthy lives than other people because their mechanical hearts would not fail. How was that startling set of conclusions reached? Preparers of the report simply *assumed* that all the operations would succeed and that the artificial heart would work perfectly. Furthermore, the report forecast that by returning 132,500 people annually to normal life, the artificial heart would add $19 billion to the GNP during the first decade of its use and another $41 billion during the second decade. The program, in short, would extend life, improve its quality for both the patients and their families, and make a "profit" for America.

Most of the studies did not adequately explore four serious technological problems: those of developing appropriate biomaterials, a pump, and a power source, and of simulating the autonomic nervous system. At the time, experts did not know of any material that could safely interact with the blood over a prolonged period without destroying it and producing clots, thereby killing the patient. Nor did they know how to design a pump with a material that could flex—like a natural heart—about 40 million times a year without beating up the blood and impairing its capacity to serve the body. Furthermore, experts knew of no power source small enough, reliable enough, and safe enough to be implanted permanently. Nor did they know how to simulate the autonomic nervous system, which, among other functions, regulates the heart so that it can shift its rate of pumping blood from the requirement for, say, sitting down to that necessary for climbing stairs.

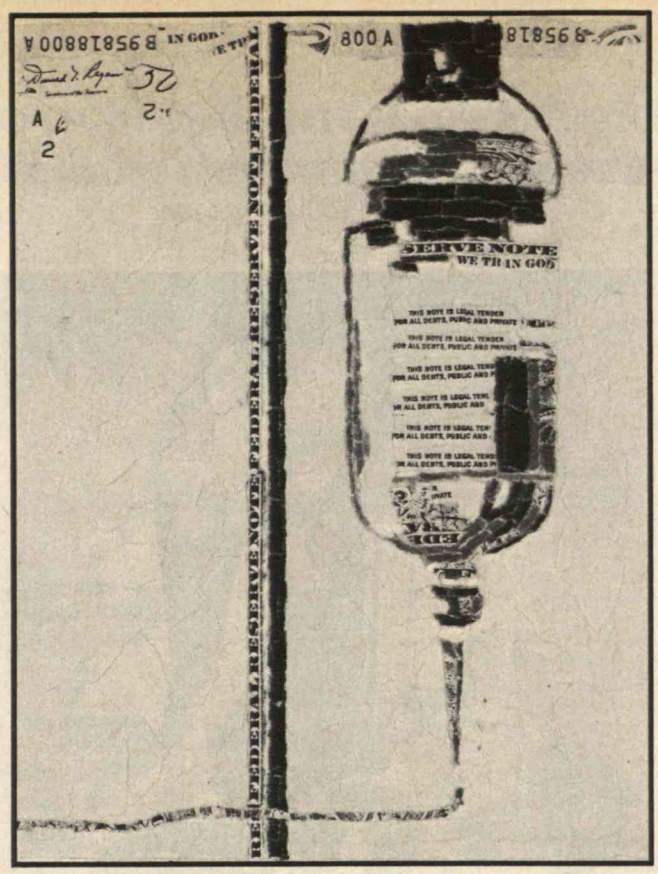
The studies did not dwell upon the possible psychological and social effects of the artificial heart on the recipient, the family, and the community. The use of a mechanical device to pluck an individual from the brink of death might create great anxieties for the recipient concerning worthiness and dependence upon the device, and would also require major adjustments by family members. For example, if the device left the recipient largely disabled and dependent on others, the individual might feel guilty and angry and the family resentful. Such problems could increase the need for psychological counseling for many people.

Additionally, a greatly successful TIAH would extend the life of millions, swell the older population, create a need for more care of the chronically ill, and strain the Social Security and welfare systems. And in the short run, if artificial hearts were scarce, questions would arise concerning who should receive them, what criteria should be used, and who should decide. For example, should the government pay for the whole research and development program and for the devices and other medical expenses or should the poor do without and the wealthy buy their own?

There was no open dispute about the quest for the TIAH. National Heart Institute officials forecast that it could be devised in about five years, at a cost of $40 million to $100 million, and that the first implant, according to their master plan, would occur on February 14, 1970—Valentine's Day. Capturing this enthusiasm, Rep. John Fogarty (D-R.I.), chairman of the House Subcommittee on Health Appropriations, declared that any delay would condemn Americans to needless death. The appropriations subcommittees, key allies of the federal health agencies, welcomed the opportunity to fund the program, and Congress comfortably endorsed it in 1964. Thus, the program has ambled along ever since at annual funding levels, discounting inflation, of about $9 million to $12 million.

From the beginning, medical experts—heart surgeons and bioengineers—and their allies in federal health agencies have shaped the issues surrounding development of the artificial heart, defined the agenda, determined how to evaluate progress, implemented the program, and spent the money. A cozy alliance with congressional appropriations and health subcommittees, which often pushed for even greater expenditures in the early years, blocked any larger scrutiny.

Even members of Congress outside this "iron triangle" relationship have shown great respect for the program. Though many enlightened representatives



have learned not to trust Department of Defense estimates, they still largely believe the promises of medical experts. These specialists seem nonpartisan, objective, and dedicated to doing good. Indeed, most people trust physicians when they pronounce on the need for technology, its cost and feasibility, and its benefits.

Although no probing public dialogue about the artificial heart occurred in the mid-sixties, there was at least one powerful dissenter—Dr. James Shannon. He was the director of the National Institutes of Health (NIH), the umbrella agency that oversees NHI and other federal institutes doing medical research. Shannon, a cardiologist, distrusted the contractors' reports and deemed the NHI schedule wildly optimistic. He believed that the science needed to develop the biomaterials, the pump, an internal power source, and the autonomic system were inadequate to achieve the quest within a handful of years, or even a decade. He decided that NHI should instead concentrate on partial heart-assist devices, especially the left-ventricular assist device (LVAD). The LVAD raised fewer scientific problems than the TIAH, could be a way-station to the artificial heart, and might meet the needs of many heart patients since left ventricular failure is a common problem.

When Skepticism Surfaced

Shannon maneuvered effectively within the executive branch to undercut the NHI program and reduce its funding. Testifying on the hill, he indicated that the project could be completed even more cheaply than NHI had proposed. Thus, he persuaded the appropriations subcommittees to deflect to other research activities some of the money originally targeted for the artificial heart. However, this undercover strategy helped block a public dialogue, a result Shannon self-righteously celebrated in 1980, decrying what he sneeringly called "the age of populism."

As Shannon had foreseen, the effort to develop an artificial heart made little progress in the first few years. The dramatic heart transplant carried out in 1967 by South African surgeon Dr. Christiaan Barnard, as well as concern about mechanical heart devices, propelled NHI to establish a task force in 1968 to analyze the issues of cardiac replacement. This group consisted almost entirely of medical people; their focus was narrow and their optimism about technology strong. Basically, their report, published in 1969, was optimistic about the costs of the program, hopeful about scientific problems, and skimpy on social issues.

The report estimated that the total cost of a TIAH (including surgical and hospital expenses) would be $10,000 to $20,000 per recipient, that the number of candidates would not exceed 32,000 yearly and thus that the total annual cost would reach the range of $320 million to $640 million. The group did not confront problems about who should pay for the artificial heart and whether it would be fair to spend federal funds to develop the device and then allow only those who could afford the expense to buy it.

In 1972, the federal government appointed a second committee to look at many of the same questions that the 1968 group had considered. This committee, composed of people in fields such as law, sociology, ethics, and political science, proved more realistic, more probing, and less optimistic about the artificial heart; it defined many profound ethical, economic, personal, and social problems.

For example, members gently raised questions about whether the artificial heart should be pursued, whether other opportunities (especially in preventive medicine) were being sacrificed, whether the quality of life with an artificial heart would be decent, what would happen if it was not, and even whether the public might wish the project to be terminated.

The committee concluded that the cost of the device and medical and surgical expenses could easily exceed $25,000 per recipient, and that 50,000 pa-

Only after Barney Clark died did his doctor admit that he had asked, "Why don't you let me die?"

tients might receive implants annually, leading to a total yearly cost exceeding $1.25 billion. Unless the federal government paid all the expenses for most citizens, the report stressed, only the rich might be able to buy a device developed largely on federal funds, and concepts of justice would be violated.

What would happen, the committee shrewdly asked, if artificial-heart recipients faced roughly the same problems as kidney-dialysis patients? Many of those patients did not live normal lives, and their suicide rate was 600 percent above the normal rate. They sometimes became preoccupied with their dependence upon a machine, worried excessively about costs, developed guilt feelings, and emotionally burdened their families.

"Perhaps the worst outcome," the committee warned, "would be for the device to work just well enough to induce patients to want it . . . but not well enough to prevent typical recipients from burdening others." Once the device was developed, committee members feared, society would probably "balk at any explicit decisions which would deny life for those for whom it could be technologically preserved." But if the quality of life was expected to be poor, "society might well elect to restrict development" before the device was created. The committee wisely understood that terminating a life-saving technology, even on grounds of inadequacy, would be much easier—morally and politically—if done before the technology was developed.

Not only was this second committee, not wedded to biomedicine, more critical than the 1968 task force; it gave better advice, even on technology. For example, members warned that a nuclear-powered heart might irradiate the recipient and people nearby, noted that adequate lead shielding would probably make it too heavy for the chest, and suggested that the recipient would be a target for kidnapping because of the $25,000-$53,000 value of plutonium. These criticisms persuaded the government to phase out funding of the nuclear-powered heart.

It is significant that the two committees, which came to rather different conclusions, were strikingly different in composition. The contrast suggests the danger of allowing medical experts almost exclusively to shape and define medical policy. The greater success of the 1972 panel in foreseeing the problem involved in developing the artificial heart suggests that experts outside medicine, and possibly the general public, should have a role in policy decisions in medicine.

The Saga of Barney Clark

By the late seventies, bioengineers had devised better pumps for the heart and had found a material (polyurethane) that they believed could safely interact with the blood. However, they had made little progress in simulating the autonomic nervous system and had failed to build a compact, safe, and reliable power source for implantation. At the University of Utah, a group led by Dr. Willem Kolff, inventor of the artificial kidney, and Dr. Robert Jarvik, a young protege, had put together a partly implantable artificial heart that was being tested on calves. Known as the Jarvik 5, it and its successor, the Jarvik 7, tethered the calves to a large external power console; to test the hearts, the animals walked on a treadmill.

The Utah group was optimistic that it had solved the biomaterials problem, but two others remained. A number of the animals died of infection because the tubes into the body broke the skin and created a ripe area for sepsis. And calcium deposits built up in the mechanical heart. Two possible explanations emerged for the deposits: either the biomaterial was

PHOTO: WIDE WORLD

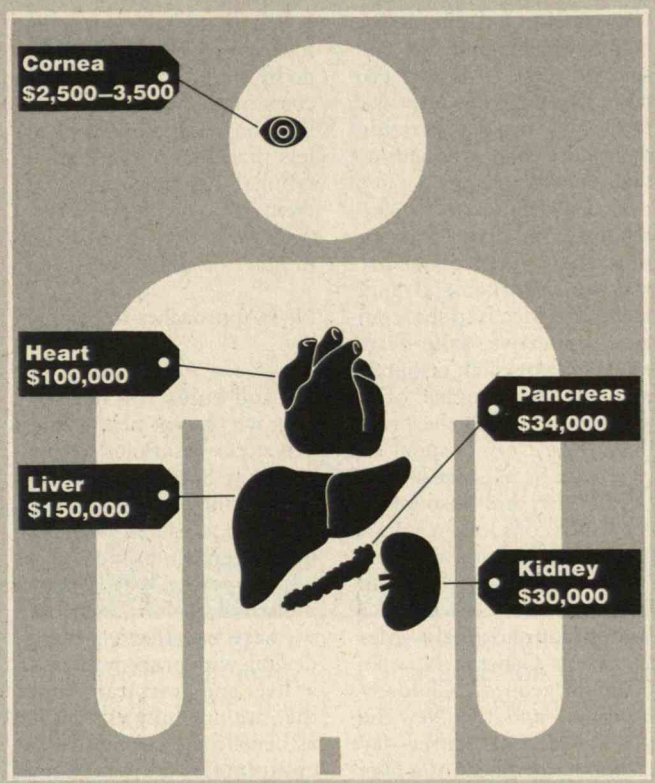
Irresistible Medical Technologies: Weighing the Costs and Benefits

BY HARVEY V. FINEBERG

ONCE upon a time, doctors lived by two simple precepts. First, do no harm. Second, do all in your power to sustain the life of your patient. In their pure form, these rules no longer suffice. Science, new medical technology, and the economic realities of contemporary health care have overtaken them. Many powerful new drugs to combat dire diseases do indeed harm as the price of attaining hope for a better outcome. Life-support technology can sustain an insensate existence that most of us would not deem worth living. We need doctors today who know how to balance high-stakes risks and benefits, who know when to stop, and who realize that value-laden decisions about new technology are not theirs to make alone.

The most basic economic reality in medicine today is the fact that our resources—public and private funding, hospital space, professional time—are finite. Dollars spent for intensive hospital services, for example, cannot be used for primary medical care. Medical costs continue to soar, and our love affair with expensive new technologies is partly responsible for that upward spiral. A recent study by the congressional Office of Technology Assessment found that increased use of medical technology, such as new drugs, diagnostic devices, and surgical procedures, accounts for nearly one-third of the increase in Medicare costs over the past five years. As costs continue to escalate, we face increasingly difficult choices on how to spend our shrinking health-care dollar.

Major-organ replacement is perhaps the most visible example of this conundrum. The capacity to transplant organs such as hearts, livers, and kidneys offers unprecedented hope for afflicted patients and their families. It is hard to resist such life-giving miracles of medical technology when the victims are visible—like the newborn baby dying of congenital liver disease. Yet these technologies are also extremely costly and, at this point, of uncertain long-term benefit. Furthermore, major-organ replacement has become available at a time when our health-care system is poorly equipped to decide who should benefit from these technologies and who should pay.



Organ replacement is an expensive way to save lives and may take resources away from more effective preventive services. For instance, we seem more willing to save babies whose livers do not work than to ensure adequate prenatal care for all pregnant women. We seem more eager to improve lung transplantation than to help people stop smoking.

The most serious drawback of organ replacement is that it is an expensive way to save lives. American taxpayers now pay several billion dollars each year for the treatment of end-stage kidney disease, much more than anticipated when the federal Medicare program started covering kidney dialysis and transplantation in 1972. And though expensive, a $30,000 kidney transplant is much less costly than a heart transplant at $100,000 or a liver transplant at more than $150,000. Although these costs will fall with technical advances and experience, substantial sums are ultimately at stake because the pool of potential recipients is large.

Perhaps an affluent society can afford to support organ replacement for all patients who might benefit from it. But the same health-care resources could be used in less dramatic ways with greater benefit. Resources that a hospital devotes to heart transplants, for example, are unavailable for other services such as replacement of heart valves that are clearly more beneficial to more patients.

Furthermore, money spent on exciting new procedures becomes unavailable for even more effective preventive services. According to the Centers for Disease Control, more than 20 percent of American children have not yet been fully immunized against polio by age two. Tens of thousands of Americans perish each year in automobile and other accidents—the leading cause of death among teenagers and young adults aged 15 to 34. But we have yet to insist on safety seats and restraints for all infants and adults riding in automobiles. As a society we seem more willing to save babies whose livers do not work than to ensure adequate prenatal care for all pregnant women. We seem more eager to improve lung transplantation than to invest in better programs to help people stop smoking.

This tendency to support visible "wonders" of health care and ignore the invisible efforts of prevention is a regrettable part of human nature. But there is a great deal more that our society should do to evaluate each new technology before we fully embrace it.

HARVEY V. FINEBERG is dean of the Harvard School of Public Health.

DIAGRAM: OMNIGRAPHICS

Promoting Public Debate

What do I specifically propose? To begin with, health professionals must explain publicly what is known and unknown about the benefits, risks, and costs of new technologies. The public, health professionals, and policymakers should air their views on the worth of these technologies and the trade-offs inherent in spending money on them. Such a public debate could be held through open conferences, lectures, talk shows, and extensive media coverage—much the way nuclear arms control became an issue of widespread concern.

The way we pose questions about medical expenditures is all-important. If asked "what is it worth paying to save a life?" we are tempted to respond "whatever it takes." A more pertinent question is "where will additional dollars produce the greatest health benefits?" That question forces us to confront trade-offs in health investments. In making these investments, we should keep in mind the health of unidentified individuals as well as the visible victims of disease.

Policymakers in each state or region can also limit the number of hospitals that have access to costly and not-yet-perfected devices and procedures. This would be a particularly effective approach in the case of organ transplantation. Such restrictions not only assure that hospitals have the needed array of clinical, laboratory, and support services for optimal care of transplant patients. They would also help our health-care system match its capability for transplantation with the number of procedures society is willing to pay for. The availability of new technology, the current fee-for-service system, and the medical bias toward action all conspire to raise costs and promote an aggressive approach that occasionally provides more care than a patient actually needs.

A consortium of hospitals interested in doing a particular transplant procedure may be a workable arrangement. The idea is to share surgical expertise, take better advantage of slack resources, and limit the number of institutions offering the procedure. Not every hospital can or should be a leader in every technology, and hospitals already in a consortium have an interest in limiting the number of other hospitals that offer the same procedure. In Boston, four hospitals—Massachusetts General, New England Deaconess, Children's Hospital, and the New England Medical Center—are currently members of a liver-transplant consortium.

Policymakers can also limit the number of centers offering new technologies by changing the way hospitals are reimbursed for services. For example, under a new Medicare policy, hospitals in most states now receive a fixed sum for each patient in a particular diagnostic grouping, such as uncomplicated heart attacks. This system gives hospitals an incentive to avoid unneeded tests and shorten lengths of stay to keep their costs within the fixed payments. Laboratory tests, x-rays and drugs, and other ancillary services amount to more than half the costs of hospital care, and many economies in these areas would not compromise the quality of patient care.

In Massachusetts, hospitals can be reimbursed only up to a certain amount for all patients, according to a complicated formula. Currently, hospitals can raise this ceiling for each liver transplant they do by about 30 percent of the costs of the procedure. I believe hospitals should receive less than that amount of additional funds to encourage them to cover the costs of transplantation from savings in other areas.

New Approaches to Payment

We must also change the ground rules for deciding how we pay for new medical practices. Insurance companies now base such decisions on whether a procedure is classified as established—and hence reimbursable—or as experimental—and hence nonreimbursable. However, we have no effective way of dealing with procedures, such as liver and heart transplants, that are not fully established as beneficial but that are not completely experimental since some have clearly saved lives.

Mired in this intellectually pointless debate about classification, policymakers cannot attend to more basic value judgments about whether the public can afford to pay for new procedures, whether current policies are fair to all patients, and whether other uses of the same resources might be more worthwhile. Insurance carriers now decide whether to pay for a procedure that is neither "established" nor "experimental" on an uneven, case-by-case basis, often under pressure from a particular family or community. That is not conducive to just social policy.

I propose that such procedures be included in a third category—investigational—and that the decisions about insurance coverage be made by a national body of health professionals, policymakers, and consumers under the aegis of an organization such as the Institute of Medicine, an arm of the National Academy of Sciences. State and local policymakers and the public can use these recommendations to decide which institution should use what new technologies.

Among the medical technologies, organ transplantation is unique in its dependence on human tissue obtained through consent. Transplantation should not be constrained by a lack of suitable donors. Public funds should be spent to improve our system of organ donation and retrieval, especially to support regional, nonprofit organ banks.

Some thoughtful observers advocate a system of presumed consent: the organs of an individual who dies can be used unless he or she has explicitly forbidden that use. Such a system is in place in a number of countries, including many in Europe. While this policy would obviate trying discussions at the time of family grief, it places the burden of demurral on the individual, and policymakers and the public may resist it as overly presumptuous.

Short of presumed consent, we could do much more to promote organ donation. Our society has not supported this concept with anything like the vigor applied to convincing people to register their credit cards for an annual fee so that stolen cards can be easily canceled, for example. Congress should fund programs to solicit healthy, voluntary donors whose commitments would be honored when they die.

We must also develop more uniform criteria for selecting

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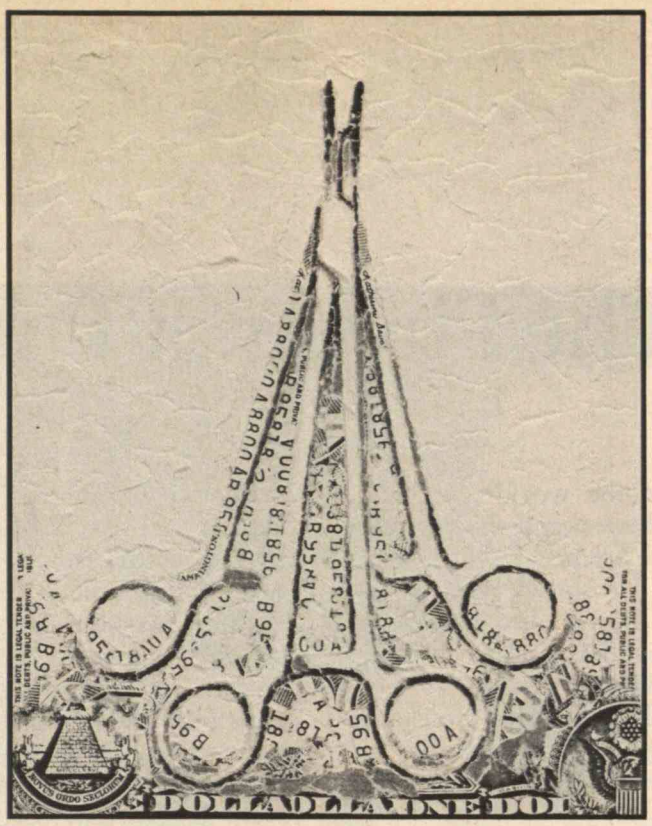


not fully blood-compatible, or the calves, because they were still growing and had considerable calcium in their blood, were producing deposits that adults would not. The ambiguity would not be resolved until the mechanical heart was tested in older animals or an adult human. Ultimately the test occurred in 61-year-old Barney Clark, who suffered from cardiomyopathy, an irreversible degenerative disease of the heart muscles.

When the Utah group delivered its test information to the Food and Drug Administration (FDA) to gain approval for experimental use in a human, it provided results from tests on both the Jarvik 5 and 7, probably because it did not have adequate information on the 7 alone. The group had also been careless in keeping records on use of the heart's valves. Because of their $500 cost, valves were transferred to new artificial hearts when calves died, so the reliability of individual valves was unclear. Occasionally they had broken—perhaps as many as 20 times. At least five animals had died as a result.

Nevertheless, the FDA granted approval, and on December 2, 1982—the fifteenth anniversary of Dr. Christiaan Barnard's first heart transplant—Dr. William DeVries and his Utah team inserted a Jarvik 7 in Barney Clark amid the strains of Ravel's *Bolero*, chosen by Jarvik.

Dr. Chase Peterson, then vice-president for health sciences at Utah, likened Barney Clark to Columbus: "He is striking out for new territory." The Utah doctors stressed that they had rescued Clark from the brink of death; because his cardiomyopathy had suddenly become more serious, they had moved up the scheduled operation by about half a day to save his life. In their interpretation, therapeutic intervention and human experimentation were comfortable allies.

Reporters camped out at Utah, as the events were front-page news. Jarvik and DeVries became medical heroes. And the world watched as serious problems developed—a broken ventricle in the mechanical heart on the operating table, bubbles in the lungs and a second major operation, seizures, a broken valve and a third major operation, serious nosebleeds and thus another operation, mental disorientation, pneumonia, failure of Clark's kidneys and other natural organs, and then death after the 112 days.

The carefully managed publicity from Utah stressed the pathbreaking nature of the experiment, emphasized Clark's courage, sometimes predicted that he would recover, tended to minimize and even conceal many of his difficulties on the artificial heart, and belatedly disclosed some problems. Only after the patient died did DeVries admit that Clark (earlier likened by Peterson to a rugged old sagebrush) had asked a few times, "Why don't you let me die?"

Clark's own hopes and expectations remain unclear. After seeing the calves tethered to a power console about two months before the December operation, he had rejected the artificial heart because of the poor quality of life it allowed. As his condition deteriorated, he changed his mind. "I don't think he really thought it would succeed," his son, a surgeon, recalled. After his father's death, the son stressed: "His interest in going ahead, he told this to me, was to make this contribution [to research], whereas the only other way was to die of the disease."

Before and after the operation, various experts gave their opinions. Jarvik had earlier forecast that "it's likely a patient could live a year if he lives a day." Dr. Yukihiko Nosé, an artificial-heart researcher at the Cleveland Clinic predicted that Clark would live at least six or seven months, since a few animals had lived nine months. Afterward, Peterson admitted that "we felt . . . that Dr. Clark would die in the first day or two or that he'd leave the hospital in about 10 days."

Dr. Denton Cooley of Houston's Texas Heart Institute, the world-famous heart surgeon who had twice used artificial hearts temporarily before trans-

Continued on page 62

The Physics of Fun

ROB Schuller may be the world's youngest physics teacher. Each weekend the Houston Museum of Natural Science pays this 12-year-old to play with toys. He shows visitors—especially the smaller variety—how to discover science while having fun. Rob's toys have mass, velocity, inertia, momentum, and weight. His toys "feel" gravitational and centripetal forces. They accelerate and decelerate. Through toys, Rob uses familiar experiences to draw children willingly into the realm of physics.

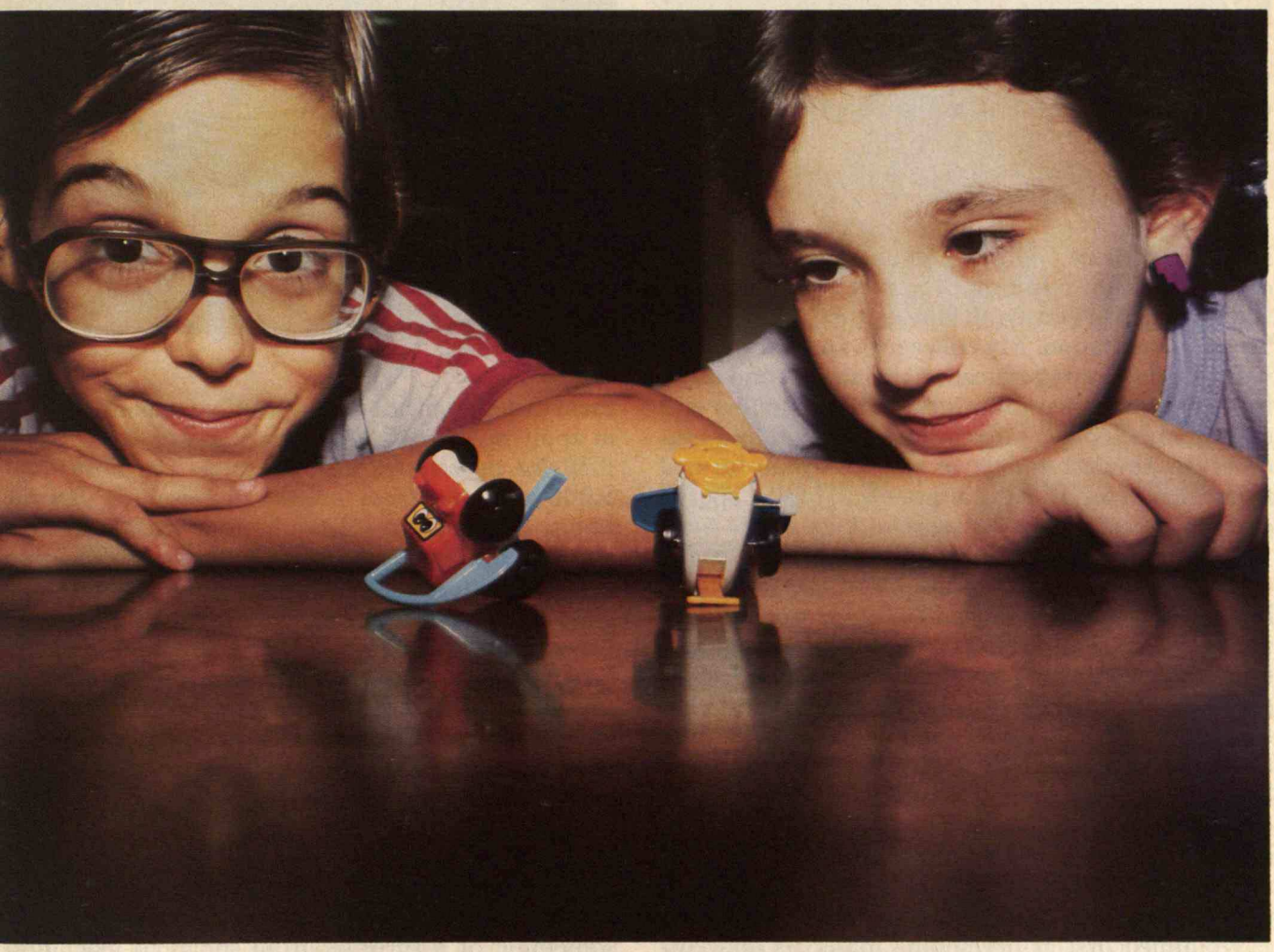
Rob begins his show with the simplest of toys—the ball. He drops a light ball and a heavy ball from the same height at the same time. The result often surprises his audience, and Rob asks the children to "help" him explain what happened. He guides them along by asking if it is harder to pull a loaded cart or an empty one. Together, they determine that the heavy ball receives more gravitational pull, which it needs to fall at the same rate as the light ball. Rob then shows his expertise at tossing a ball straight up and catching it. He asks where the ball will fall if he repeats his toss while walking. Most of the younger viewers expect the ball to drop behind him. Another surprise: the ball shares Rob's momentum and returns to his hand.

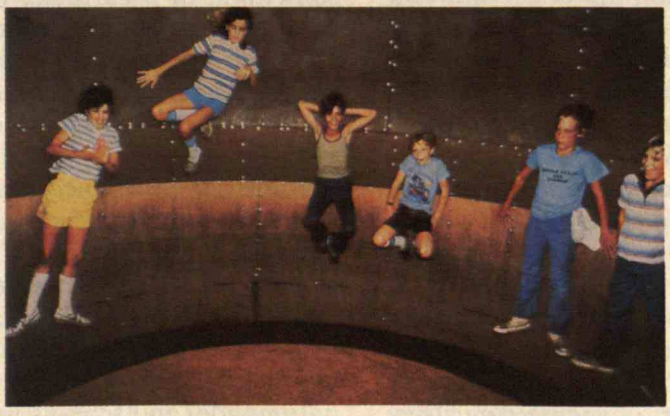
Next, Rob rolls a piece of clay into a ball and drops it. Splat! But he says momentum can make the clay ball bounce six feet high. The trick is to stick the clay ball on top of a bigger, bouncier ball. He drops both balls, which his viewers know will fall at the same rate and arrive together. The big ball receives an upward push from the floor and starts to climb. The clay ball on top captures the bigger ball's momentum and flies upward. Rob then drops the clay ball into a jar of water: it sinks with a splash. He asks for help in making the ball float. But curious viewers must wait until the end of the program to see how dense clay can be made buoyant—with the aid of physics. The trick, of course, is to shape the clay into a boat.

The momentum story continues with Rob's favorite toy, the water rocket. He first fills the small rocket with air under pressure. When the air is released, its downward momentum shoots the rocket upward in a classic example of action and reaction.

BY CAROLYN SUMNERS

Whether they're hanging upside-down on a roller coaster or monitoring marble momentum in the classroom, kids readily enter the realm of science through toys and amusement parks.





Flipping toys feature fascinating physics, and amusement park rides allow kids to truly get inside science concepts.

PHOTOGRAPHS: GARY YOUNG

Inductive physics, learned from enjoyable experiences and memories, makes sense to kids.

Rob then asks his rocket fans to predict what will happen when he adds water to the compressed air. Taking careful aim—remembering where the water will go—Rob fires the rocket. The water adds mass and therefore momentum to the escaping air and the rocket soars even higher.

The World as Laboratory

Rob's Science in Toyland demonstration grew out of the museum's Informal Science Study, funded through the University of Houston by the National Science Foundation. My colleagues and I at the museum are developing educational materials and classroom programs that draw on children's familiar and enjoyable experiences to teach the language and concepts of physics. Inductive physics—that learned from memories of toys, amusement parks, sports, and playgrounds—makes sense to kids.

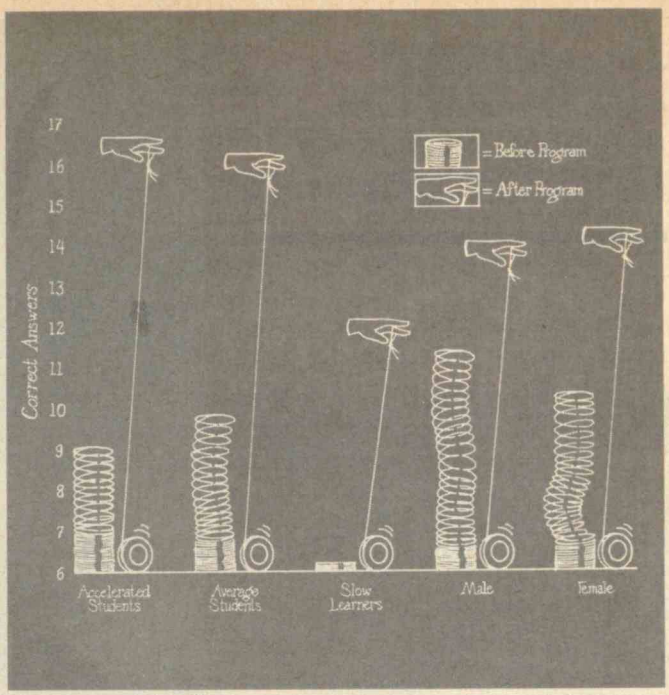
A sixth-grade girl inspired the study. I was trying to explain to her the "location" of the floor of a hypothetical space colony and why she wouldn't fall inward. But all my efforts, including swinging a bucket of water over my head, only caused more confusion. Finally, a sympathetic classmate told her to think about the rapidly spinning Barrel of Fun at the local amusement park. I will never forget the look of understanding on her face—she now had an experience to learn from. She could "feel" the centripetal force pushing inward from the sides of the barrel as its bottom dropped away, providing a structure upon which she could build abstract concepts.

We aimed first at developing materials and curricula for the middle grades—roughly five through nine—since this is the period when kids too often decide to "tune out" science. For them, science must become so interesting and meaningful that it is worth remembering and pursuing. We found that even students who had never made a contribution in science class could describe the feeling of zero gravity while rushing down a roller coaster hill and the 4-g valley that follows.

We've since developed programs for students in all grades, including accelerated students. Older students not only tackle more difficult scientific concepts; they also get into matters of engineering. They can probe the mechanical details of how toys work, or they might analyze blueprints and accelerometer readouts from roller coaster rides. We even challenge them to design their own toys and rides as an exercise in applying theoretical concepts.

We've now tested our programs on more than 5,000 students from around the country. In St. Louis, for example, 12 ninth-grade classes spent a month working with our materials—experimenting with toys, studying amusement park rides, and topping it off with a trip to the Six Flags Over Mid-America park. We tested them before and after the program, measuring their knowledge in three areas: comprehension of mechanics concepts; recall of science experiences; and ability to apply mechanics concepts to new situations. Students of all academic abilities showed significant learning gains in each category *(see chart, opposite page)*, with slow learners recording the same percentage gains as accelerated students. Girls, who began with lower scores, reached or exceeded boys' scores. This came as something of a surprise; from sports to machines, most mechanics experiences have a definite "male" bias. But we found that the girls had ridden more amusement park rides more often, a fact that gave them a relevant "knowledge base" for learning about physics.

Fueled by such successes, the materials and curricula developed in the Informal Science Study will soon be "going national." The Department of Education (DOE) has reviewed the programs and will include them in its National Diffusion Network—a list of educational programs that the department deems effective. The list is sent to school districts nationwide, and schools interested in our programs can contact us. We will provide materials and conduct workshops for teachers on a shared-cost basis using DOE funds soon to be appropriated.



Teaching science through fun works. Ninth graders tested before and after experimenting with toys and rides chalked up major learning gains. This graph charts scores for comprehension of mechanics concepts, often difficult to teach.

Opposite page: A toy scientist uses a yo-yo meter to "see" forces on a roller coaster. Left: Slinkies are great for gravity races. The stretched-out slinky won. Why? Because the center of its mass was lower to begin with.

Yo-Yo Meters and G-Force Detectors

Now let's take a trip to an amusement park with Amy O'Neal and Elizabeth Gregory. Amy, age 12, and Elizabeth, age 11, became "computer physicists" this summer in a week-long course we ran at the museum. They began by running computer programs we've developed that simulate many thrill rides. The girls designed loop coasters and watched riders stick tight even when upside down. They tilted curves so banking angles would hold riders squarely on their seats. They played arcade-style basketball with properly angled parabolic arcs. They gave just enough spin to a gravity-defying barrel so passengers would cling to the walls. They made changes that could never be made in a real park, creating dangerous rides without risking a rider's life and limb. In all, Amy and Elizabeth began to see the physical principles behind these familiar rides.

The girls then joined about 300 other computer physicists on a laboratory trip to Astroworld. They went equipped with scientific instruments and measuring devices picked up at a toy store. Elizabeth became an expert with the yo-yo meter, which she used to "watch" the forces she experienced on the rides. For example, on a suspended roller coaster called XLR-8, Elizabeth watched the yo-yo swing outward at each banked turn. The force of her body pushing against the seat confirmed the yo-yo's reading—the centripetal force produced by the banked curve exactly matched gravity's tug. The yo-yo proved that she would not fall off or fly away on this ride. On the scrambler, Elizabeth's yo-yo became a pendulum swinging back and forth. As she moved through the ride's complex spirograph pattern, her pendulum yo-yo faithfully maintained its swing, tracing each path in reverse as viewed by her moving eye.

But her most dramatic moment came on the loop coaster. Initially holding the yo-yo in her hand, with the string tied to her wrist for safety, Elizabeth released it when she was upside-down at the top of the loop. The yo-yo seemed to fall "up" rather than dropping to the ground. As she had learned in class, she was traveling so fast that the yo-yo, sharing her momentum, kept going in a straight line. She, however, was curving downward in the loop, so the yo-yo ended up in her lap.

Amy favored the paddle ball—a ball attached to a paddle by an elastic string—and turned it into a g-force detector to measure acceleration. Astronauts during lift-off may pull 3 g's, experiencing three times their normal weight, while in the weightlessness of orbit they experience zero g. To calibrate her g-force detector, Amy held the paddle upright and marked the spot where the ball rested normally—representing 1 g. She added a second ball to the string, which caused the elastic to stretch as far as it would with one ball under 2 g's of force, and marked this spot. She then repeated the process with a third ball to mark 3 g's.

DIAGRAMS: ELIZABETH SLOTE

For many students, science must become so interesting and meaningful that it is worth remembering.

On the roller coaster, Amy's detector showed the reduced g force of each drop and the extra g's encountered in every valley. Then she went on the Sky Screamer, which drops passengers from a 10-story tower. Amy plummeted for two seconds of free-fall followed by a landing curve that braked her descent. First the paddle ball floated freely in front of her—a certain indication of her weightless condition. As she entered the landing curve, the ball reached a reading well over 3 g's. She can carry this experience with her as a real-life example of physics in action.

Several parks around the nation are now using the materials, including physics workbooks, that we've developed. For example, the Six Flags park at Magic Mountain in California and Great Adventure in New Jersey run special physics "field lab" days, and the Six Flags Over Texas park is planning a similar program for physics and physical-science students. The Iowa Junior Academy of Science is testing a physical science laboratory at Adventureland in Des Moines using all of the eighth graders in the city's public schools. Both teachers and students are enjoying the attention. For years schools have rewarded the band, glee club, and sports teams with trips. It is encouraging to see a similar privilege given to science students.

Toys in the Classroom

For the past 3 years I have presented workshops at teachers conventions around the country. The workshops emphasize how to bring student experiences into the classroom—from science show-and-tell activities in the lower grades to toy activities and amusement-park laboratories for older students. In Houston, I've watched toy labs grow in several elementary and middle schools, where children seem to thrive when studying the world in miniature.

Some toys mimic human behavior—flipping, swimming, hopping, rolling, jumping, waddling, and walking. Whether they wind up, roll down, rev up from being pushed, or use batteries, these toys all have a power source somewhere. Describing the energy flow in the mechanical devices offers a simple introduction to the principle of energy conservation.

Toys that roll are meant to be raced, of course. Proper lab equipment includes a long downhill ramp of plastic or plywood that slopes gently to a hard floor straightaway. Some racers inevitably roll faster for very scientific reasons. Students discover that wheel friction is a killer, but several of the pint-size experts in this field testify that applying graphite works wonders. Crooked wheels waste too much of the precious gravitational energy. Wheel quality almost always takes precedence over wheel size. Aerodynamic styling can help if the race is close. Students who know that all objects fall at the same rate are often puzzled about what happens when mass is added to racers. Using clay and trial-and-error tactics, they soon learn that mass makes little difference on the downhill roll, but the extra momentum carried onto the straightaway makes heavier racers better every time.

After one great race, a female contestant requested that we use dolls in a demonstration. But that pointed to something that had been bothering us: dolls—traditionally "girls' toys"—don't lend them-

Amy O'Neal and Elizabeth Gregory of Houston became computer physicists this summer. They tackled a breathtaking free-fall ride via computer, manipulating the ride's mechanical properties (right). Amy finally put theory to the test at Astroworld, where the freefall dropped her 10 stories (far left).

Amy measured her descent with a paddleball "g-force" detector. Floating before her face, the ball testified to her weightlessness (left). The detector measured more than 3 g's during braking, similar to the force on an astronaut at lift-off.

selves easily to science. Staring at a doll and wondering "where's the physics" only leads to frustration. Dropping or throwing dolls in the name of science surely provides little encouragement for budding female scientists. Finally, we hit on the idea of safety.

Roller skates that clamp over shoes make excellent cars for carrying dolls. The students would crash the cars and study the results, adding safety features for the next crash. Doll-sized seat belts, shoulder harnesses, head rests, and padded dashboards grew from classroom supplies. Class interest ran high: the girls cheered when the dolls survived, and the boys rooted for the wreck.

Another class modified this idea, replacing the dolls with raw eggs. Each egg had a painted face that had to remain visible during its ride. A ramp running abruptly into a wall guaranteed equally forceful crashes for all participants. Losers cleaned up the mess. As an interesting safety note, the sole surviving egg was protected by an air-bag system made from a balloon.

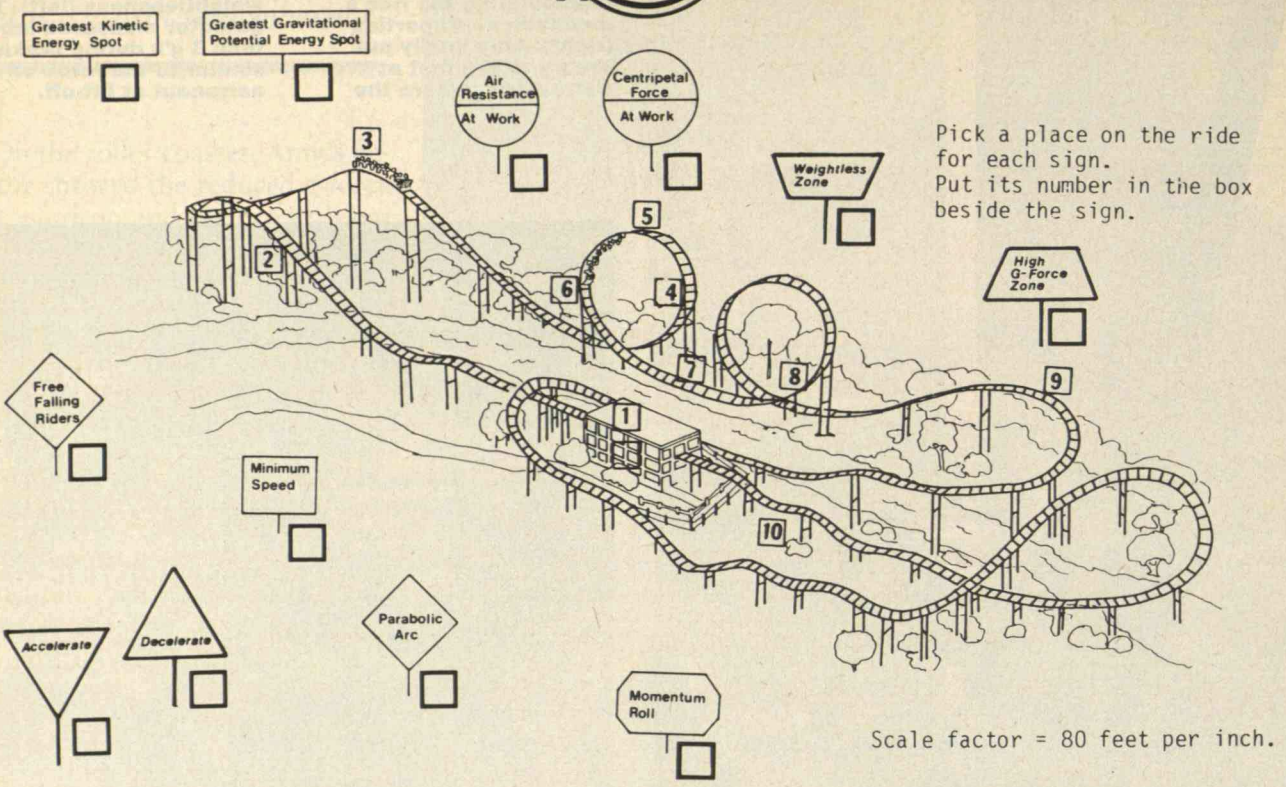
Flipping toys also make fascinating physics. With a push from its long curled tail, a toy cat can roll over. Tiny legs flip out and push toy cars and planes upside down and over. With a spring-loaded kick, a toy mouse flips high in the air and lands on its feet. A simple description of these forces and their directions is a lesson in Newtonian mechanics. Adding clay weights shows the delicate balance of each toy acrobat.

Marbles make excellent lab equipment. A ruler with a center trough along its length quantifies the marble player's art. Marbles of different sizes and speeds can be rolled along the trough into each other with great head-on accuracy. Students can see momentum passed from marble to marble in each collision. Students who do not speak algebra can still see that mass and velocity are both important in marble mechanics. A small marble must travel twice as fast as a marble with twice as much mass to stop it. And for observers, clear marbles make handy convex lenses that provide upside-down views of the world.

The slinky has long served teachers as a medium for demonstrating longitudinal (soundlike) waves and transverse (lightlike) waves. But we've also solved one of the greatest problems with slinkies: what to do when a slinky is stretched or bent. Damage usually strikes at the middle, rendering the toy useless. Such a slinky can be cut in half. The halves can then be dropped from the same height, with one

DISCOVERY ACTIVITY

LOOP COASTER



Pick a place on the ride for each sign.
Put its number in the box beside the sign.

Scale factor = 80 feet per inch.

Height of first hill	- 116 ft	Weight of coaster	- 378.5 tons (approx)
Angle of first drop	- 36°	Length of train	- 49 ft
Height of each loop	- 70 ft	Chain speed	- 354 fpm
Maximum g-force	- 5.9 g	Frontal area of train (intersecting the wind)	- 3.7 ft x 2.8 ft
Minimum g-force	- 2.0 g	Horsepower of chain motor	- 200 hp
Speed limit	- 50 mph	Round trip time	- 111 sec
Minimum speed	- 3 mph	Round trip distance	- 1942 ft
Minimum rider height	- 4 ft		
Ride capacity	- 28		

half compressed and the other outstretched. In seeming defiance of the "all-fall-together" law, the stretched-out slinky hits the floor first. Students finally realize that it is the centers of mass that must be at the same height to make a gravity race fair.

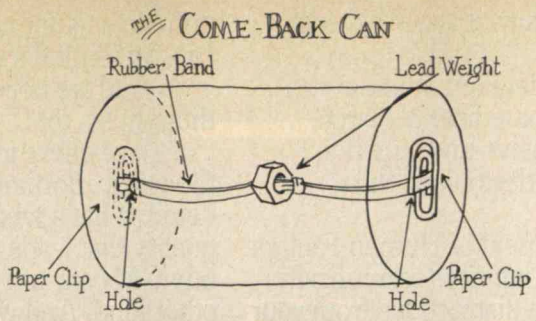
A car track with a ramp that hurls the car around a loop always proves a favorite. By adjusting the height of the ramp, students can change the car's speed in the loop. When the speed drops too low, gravity conquers inertia and the car comes tumbling off. Older toy scientists can calculate the exact height for the car's ramp in terms of the loop's diameter that gives the slowest acceptable ride. This demonstration gives students the opportunity to experiment with a model of an amusement park ride before experiencing the real thing. From watching the car, students develop an idea of what it would feel like to be inside. Going on the ride lets the learner slip inside his or her experiment to get a different perspective on the forces involved.

Students also enjoy speculating about which toys will work well in the zero-g conditions of the space shuttle. Could an astronaut yo-yo? Would a floating slinky still carry waves? Would a paddle ball be as easy to hit? Could a windup car run around the sides of a circular doorway without ever needing to be rewound? These fascinating questions have led me into negotiations with officials at NASA's Johnson Space Center in Houston. I've proposed that shuttle astronauts test some of these toys and videotape their efforts. The latest word is that this may happen during one of next year's missions. The videotapes would then be available to teachers.

Many Happy Returns

With the holiday season fast approaching, toys are on many people's minds. Anyone venturing into a

Several amusement parks across the nation now use materials developed in the Informal Science Study. This workbook problem asks students to mark where they experience various forces on a roller coaster (left).



Rob Schuller's Science in Toyland program delights children at Houston's Museum of Natural History. For example, doll-carrying roller skates provide a dramatic look at momentum in action (left). As a holiday science gift, Rob recommends the Come Back Can (above; see article for instructions).

toy store will find physics on every shelf—even though only one aisle will likely be labeled "educational." These toys, such as chemistry sets or microscopes, take a science-inclined child into the world of adult scientists. But there is as much applied science and engineering in those other toys that *all* kids want. Since many people automatically make a distinction between "fun" and "learning," the potential of these toys is often overlooked.

For those who forgo the toy store adventure, the staff of the Houston Museum of Natural Science recommends a special old-fashioned science toy. It is appropriately called the Come Back Can. Rob Schuller makes this toy from a soft-drink can, a rubber band, a one-ounce fishing sinker, and several large paper clips. He uses a nail to make a hole in the bottom of the can. He slips the rubber band through the sinker and knots it in the middle. He then feeds one end of the rubber band through the tab slot in the can top and secures it with a paper clip. With a hook fashioned from a paper clip, he pulls the rubber band through the hole in the can bottom and attaches it with another paper clip. The sinker must hang with a little slack, but should not touch the walls. The paper clips must be taped securely to the ends of the can, which may be decorated with smooth wrapping paper to add a festive touch.

Rob rolls his finished Come Back Can forward a few times to wind up the rubber band. Then he rolls the can across his stage. The can finally comes to a stop and begins to roll back. Toy scientists of all ages will be fascinated by this holiday treat while seeing an important scientific principle, conservation of energy, at work—or, rather, at play.

CAROLYN SUMNERS is director of astronomy and physics at the Houston Museum of Natural Science and co-principal investigator of the Informal Science Study at the University of Houston.

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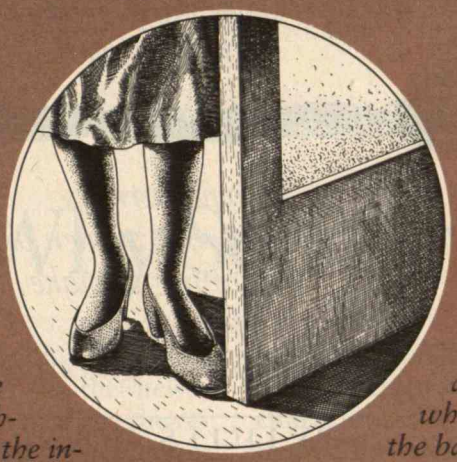
WOMEN IN TECHNOLOGY



THIS year has brought dramatic gains for American women. The first three female American astronauts have flown in space. The endurance and ability of female athletes was recognized by the inclusion of a women's marathon in the Olympic Games. And now a woman's name appears on the ballot as the vice-presidential nominee of a major party.

But these women remain the exceptions in a society that still assigns most of its leadership roles to men, especially in science and engineering. The inequity is widespread: women Ph.D.s are half as likely as their male counterparts to be hired for industrial research positions, and those who do obtain employment are only half as likely as men to advance to management positions. Women also remain grossly underrepresented on science and engineering faculties: at M.I.T., for example, the proportion is one in ten.

This special section of Technology Review *deals with three questions: Why are there so few women in science and engineering? Why should industrial, academic, and government administrators care? And what can be done to change the balance and avail ourselves of the large, untapped pool of talent that women represent?*

Our opening article examines the changing pattern of prejudice against women in science and technology and its impact on the nation's competitive ability in high technology. In two accompanying articles, a woman engineer reflects on her struggle to overcome discrimination, and an anthropologist analyzes the close-knit, male-dominated world of high-energy physics. Three more contributors tackle the controversial issue of how gender has shaped the practice of science and engineering. One author addresses the key question of how a gender-free environment might change the very nature of technology.

ILLUSTRATION: ROGER LEYONMARK

Sex discrimination was freely practiced by many universities and employers until the 1960s.

Some barriers still exist, but women are beginning to make inroads into science and engineering.

BY LILLI S. HORNIG

Women in Science and Engineering:

Why So Few?

"WOMEN prefer to kill with knives and men with guns"—or so the newspapers announced in reporting the results of a recent study. But to really draw such a conclusion, the Canadian researchers would have had to identify likely murderers of both sexes and supply them all with a full range of weapons. Only after the murders had been committed could one then add up the total number of each weapon used and speak legitimately of a "preference." The real-life situation, however, entitles one to record only that more male murderers use guns while more women use knives, as opposed to other weapons. In their quest for yet another deep-seated gender gap, the authors apparently did not consider the fact that more men than women own guns, and that almost all women have knives in their kitchen drawers. In fact, it was taken almost for granted that there must be some fundamental sex-related reason for the choice of murder weapons.

The study of women's participation in science and engineering has suffered from similar distortions of logic. For years, the belief that women's traditional roles as wives and mothers made serious careers outside the home impossible kept women out of all but a few "acceptably female" professions, which were characterized by limited opportunities and low earnings. The sciences and science-based professions, which generally enjoy high status and rewards, were deemed particularly unsuitable for women. Such attitudes were rationalized for many years on the grounds that women lacked ability, interest, or both. What they lacked most, of course, was incentive—since good academic or industrial positions were simply not accessible to them.

Engineering and the sciences have been linked to national security, and therefore to warfare, at least since the siege of Troy. Whether one counts such modern developments such as nuclear weapons, space exploration, nerve gas, and defoliants as advances or atavisms, there is no denying that the quest for international oneupmanship has financed much of scientific research, however uneasy that makes most scientists. As a nation, we also depend heavily

ILLUSTRATIONS: CHRISTOPHER BING

Women needed not only private resources but very special talents to earn a degree.

on science and engineering for our economic well-being. Together, these two basic functions make science fields of fundamental importance to national life, and many people remain reluctant to leave such matters in the hands of women.

The issue of women's and minorities' participation in science and engineering fields is becoming more urgent. Over the next decade, our young-adult population will decline by more than 20 percent nationally and by as much as 40 percent in New England. Such a decrease in the talent pool could have disastrous implications for our country's ability to maintain a position of leadership in the sciences and engineering, particularly since these areas depend on new entrants as the lifeblood of important advances. We simply cannot afford to write off, or to relegate to inferior status, nearly two-thirds of our population.

The social costs of women's under-utilization are considerable. Women scientists have often argued that the personal and psychological costs imposed on them by curtailed opportunity, token status, discriminatory employment practices, and unfairly diminished rewards are so enormous that they find it difficult to function as scientists, and sometimes at all. This argument has recently received support from a study of women chemists conducted by Judy Walrath and her colleagues at the National Cancer Institute. By reviewing data on the causes of death of women chemists from 1925 to 1979, Walrath established that an astounding 11 percent of these women had committed suicide—a rate far in excess of that for male chemists, or for scientists of either sex in any other field that has been studied.

Unfortunately, these grim statistics may well be related to the degree of discrimination in this field. In the four reports issued between 1979 and 1983 by the National Academy of Sciences' Committee on the Education and Employment of Women in Science and Engineering (CEEWISE), chemistry consistently emerged as the field with the largest discrepancy between the supply of women in the field and their opportunities.

What happens in the universities is of particular importance to the issue of women's participation. Although current wisdom tends to emphasize secondary education as the place to address the future of women in science, it is the universities that both educate scientists and serve as gatekeepers to the professions. "Choices" in education are no more independent of custom and environment than "choices" of murder weapons. In each case, people must make do with the tools to which they actually have access.

Institutions of higher education have not only a moral responsibility to ensure the full participation of minorities and women in their science and engineering programs but a considerable self-interest as well. If they fail to educate women—who now comprise a large majority of their students—for the same rewarding professions as white males, they will see their own base of social and financial support eroding in the foreseeable future.

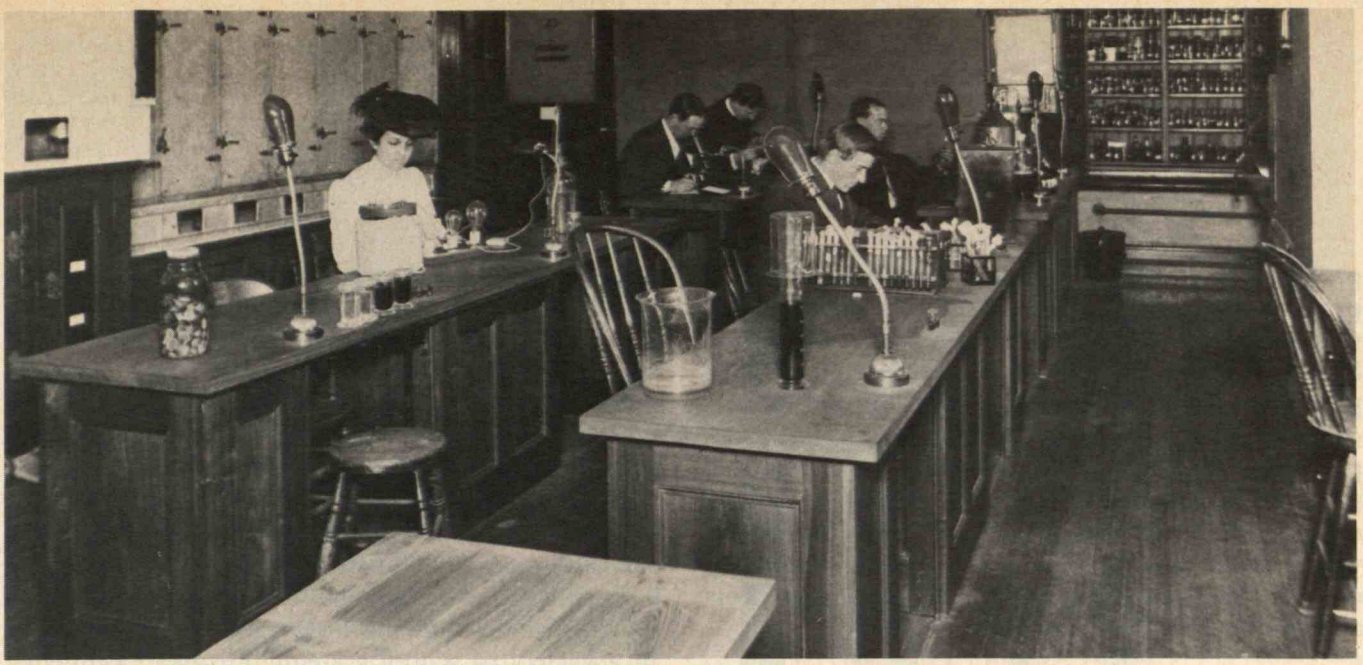
Before I discuss what can be done to ensure the full participation of women in the sciences, it would be helpful to understand some of the educational barriers that have had and still have adverse effects on women.

The G.I. Bill: A Blow for Women

At the beginning of World War II, women earned about 45 percent of all bachelor's degrees and about 13 percent of all doctorates. In 1946, however, women's proportion of degrees at all levels began to decline rapidly, with baccalaureates dropping to about 26 percent by 1950 and doctorates to about 9 percent. Women's proportion of bachelor's degrees then climbed slowly after 1950, but did not reach the prewar level again until the mid-1970s. The proportion of women Ph.D.s, which trailed the undergraduate figures by an average of about ten years, began a slow rise in the early 1960s and then a rapid climb through the 1970s to their current level of about 33 percent.

The phenomenon that fundamentally changed the proportion of men and women in higher education was the G.I. bill. Conceived by a nervous Congress as a palliative to almost certain unemployment and social unrest after World War II, the bill took no explicit notice of women. Nonetheless, it has probably affected women's educational and career opportunities more seriously than any other single event, not excluding the baby boom. Its impact continues today. In 1982, some 10 percent of all new male Ph.D.s still received primary support from this source.

The G.I. bill turned higher education into a predominantly male enterprise. Not only did more than 2.2 million veterans receive a free higher education;



they did so in the best institutions that their abilities warranted. In 1946 and 1947, when most of the returning veterans arrived on campus, they overwhelmed existing facilities, nearly doubling the prewar annual enrollment of about 1.4 million students almost overnight.

The bill truly democratized higher education for the first time—at least for men. Attending college and graduate school was no longer an exclusive privilege of the wealthy. Women, however, needed not only private resources but very special talents to earn a degree, since many universities cut down on female enrollments to accommodate the men. Some accomplished this by setting higher admissions standards for women than for men, others by simply setting a quota. The University of Michigan, for example, reduced women's admissions by 30 percent in 1946. (The Ivy League colleges admitted no women undergraduates at all before the late 1960s.) Such policies forced women into the less desirable institutions, where a lower-quality undergraduate education decreased their chances for successful graduate work and employment.

Many of the agencies that foster science education and research were established during the postwar years and have maintained close working relationships with academe. The National Science Foundation was born during these years, and the support programs for academic research sponsored by the various military departments, especially the Office of Naval Research (ONR), grew larger and more influential. Agencies such as the Atomic Energy Commission (AEC) awarded fellowships for graduate study, and thousands of science and engineering graduate students were supported by means of research grants to faculty, who could then pay students. With women students squeezed aside by veterans, the beneficiaries of this public funding continued to be almost exclusively male.

The sex discrimination fostered by this process was reinforced by institutional policies. At Cornell University, for example, quotas of "female beds" had long existed for various academic divisions, ensuring that few, if any, women undergraduates could become engineers or scientists. Indeed, sex discrimination, like other kinds of bias, was not a federal offense before the Civil Rights Act of 1964, and it was freely, even proudly, practiced by most major universities. As late as 1969, financial aid from institutional sources for male undergraduates exceeded that awarded to women by 30 percent.

In 1982, 50,000 women held science and engineering Ph.D.s, compared with fewer than 20,000 in the humanities. Today, about 4,500 women earn science and engineering Ph.D.s annually, while only 1,500 earn Ph.D.s in the humanities, and that fact speaks eloquently to the matter of women's abilities and preferences. When certain barriers to women in technical and scientific fields were eliminated by law, women increasingly moved into these areas.

Nonetheless, the belief that "there are so few women in science" persists, testifying to the strength of stereotypes regardless of their validity. Women may be less visible in the sciences and science-based professions because they still constitute only about 12 percent of all scientists and engineers. In contrast, the much smaller numbers of women in the humanities constitute a larger proportion—27 percent of the smaller humanities fields.

Three basic elements determine an individual's educational and career choices: innate ability or inclination, access to appropriate institutions or

PHOTO: MIT MUSEUM

Now that a glut of engineers is expected, schools are not recruiting women students as actively.

programs for training, and perceived opportunity to practice a chosen career and reap its rewards. Although the initial impetus for entering a particular field is certainly related to ability, an individual's perception of opportunity in that field provides much of the driving force to specialize in it. A bleak prospect, such as now exists in the humanities, will turn students in other directions. Men and women do make somewhat different "choices" in deciding which fields to enter, and we can understand why only by examining the alleged differences in their abilities, inclinations, and opportunities.

Test Differences

Few women have never had a mistake in mathematics shrugged off by a teacher or parent with the comment that it won't really matter to a female. Ascribing a lack of mathematical and ability and deficiencies in powers of logical reasoning to women is still a common phenomenon.

One of the most durable beliefs is that female deficiency in math is annually demonstrated on the Scholastic Aptitude Test in Mathematics (SAT-M), taken by nearly 1 million high-school seniors. The observed sex difference is about 45 score points out of a total range of 600. Studies aimed at identifying the origins of this differential show that most of it stems from the fact that girls take approximately one-half course less math in high school than boys—a difference that is significant because it occurs at the advanced level, generally a calculus course. That means not only that girls have had less total training in math, but that they are less likely than boys to be enrolled in a math course at the time of the test. Not surprisingly, being currently enrolled in a math course is highly correlated with better test scores.

Close examination of SAT-M data reveals other factors that bear on the observed sex difference in SAT scores, yet these factors are hardly ever mentioned in public discussion. For instance, there are now almost 50,000 more females than males in the test population each year, a difference of nearly 12 percent. That statistic suggests that males are in some sense more highly selected. In addition, college-bound boys now come from wealthier families than college-bound girls, the mean income difference being about $2,000. Test scores, like many other things in life, are highly correlated with income. Furthermore, the racial composition of the two groups is very different: there are over 50 percent more black girls than boys in the test population, and they account for 10 percent of all the girls. Many other factors that affect test scores—parents' education, type of school attended, amount of preparation in various fields, intended major in college—are also largely functions of family income. Every one of these factors favors higher scores for boys who take the test. So it seems likely that a part of the observed sex difference is a statistical artifact.

Furthermore this apparent disparity does not always exist. In studying how mathematics is taught in a variety of school systems, Elizabeth Fennema, Elizabeth Sherman, and their colleagues at the University of Wisconsin found that some schools and some teachers turn out female students whose scores are the same as their male classmates'. Although the specific factors that may produce such results have not yet been identified, this work does suggest that some teachers and principals create an educational climate that fosters equal achievement by both sexes.

Unequal Access

Just as SAT scores are skewed by little-publicized factors, so are the selections made by students headed for college. These "choices" lead women, more often than men, to enroll in small colleges rather than universities. The most distinguished universities admit significantly more men than women. In private institutions, the ratio is currently of the order of 60:40, and many of these institutions, most notably the Ivy League schools, were all male until 1969. Today these universities claim (and most people believe) that they practice sex-blind admissions because equal proportions of male and female applicants are admitted. Actually, the unequal ratios that exist today are often more likely to result from deliberate recruitment and selection by gender. The major public universities also have unequal male-female ratios, most being in the 55:45 range.

All these differences in access mean that fewer women than men attend institutions where serious undergraduate training in science and engineering is even an option. The liberal-arts colleges and state colleges where women are overrepresented can seldom offer the full range of science and engineering subjects, nor can they offer the facilities and intellectual climate that attract distinguished research faculty. Thus, far fewer women than men have the

Women not turned aside by overt discrimination may encounter more subtle barriers.

opportunity to attend institutions that can educate them to become competitive scientists or engineers.

The overall financial-aid picture also appears gloomier for women than for men, equal-opportunity mandates notwithstanding. In a book called *Women's Inferior Education*, Blanche Fitzpatrick shows that in the 1970s women were still receiving less public and institutional support than men, in all types of institutions and throughout the country. Yet we know from the SAT data that women students come from poorer families and are likely to need more aid. Are they therefore forced to avoid the better and more expensive colleges, and thus to restrict their choice of courses and careers? Are they making informed choices, or has no one ever told them the differences among the types of schools? Have they been offered financial aid similar to that offered men and refused it? No one yet knows the answers, but they clearly bear significantly on the college choices that men and women make.

Even when men and women arrive at the same colleges with similar preparation, they end up distributed differently among academic fields. For instance, nine times as many men major in engineering as women and three times as many men major in the physical sciences, yet only one-third as many men major in foreign languages or education. This difference may stem from students' perceptions of opportunity. Male and female students alike believe their majors to be preparation for an occupation; comparatively few men, however, see their future in nursing or elementary education. Such fields seem inappropriate not only because so few men are in them but also because men have a wide range of alternatives. At the same time, women see few role models in untraditional fields, and thus are not apt to think of professions such as naval architecture or high-energy physics as offering them good prospects.

More Subtle Faces of Discrimination

Those women who are not turned aside by overt reality may find other, more subtle barriers in their way. Take, for example, a policy that existed at Carlton, a distinguished coeducational college in the Midwest. Despite the high reputation of this school's geology program, women seemed to avoid it during the 1970s even as their numbers increased in other science departments. The explanation, a chagrined faculty member eventually confessed, was that the

senior field trip—the highlight of college for geology majors—was open to men only "because of the chaperoning problem."

Similar restrictions still occur in nearly all colleges and universities, some with devastating effects. A large state university, for example, had two biochemistry departments, one in the agricultural school and one in the college of arts and sciences. One department had about half women and half men as graduate students, the other only men. Not until the department with women overtook the other in reputation did the chairman of the latter department allow women's applications for admission to be reviewed along with men's. Previously, he had tossed the women's applications on a corner table and announced that any faculty member who really wanted a woman could take his pick.

Similar problems used to be common in professional education. Many veterinary schools, for example, held that women could not deal with large farm animals such as angry bulls, and therefore would admit few women. These lucky candidates were not, however, selected on the basis of strength or speed, but because they had high grade-point av-

Most of the faculty members who made discriminatory rules about women are even more powerful now.

erages—3.5 as opposed to the 2.5 required of men, in the case of the University of Pennsylvania. What academic brilliance had to do with taming angry bulls was not explained, and the issue was eventually rendered moot by the use of tranquilizers.

There are two reasons to review the historical record of sex discrimination, neither of which is to embarrass anyone. First, those who ignore the lessons of history are doomed to repeat them, as Santayana so lucidly observed. And this particular past reveals that even scientists who pride themselves on their objectivity and unbiased judgment were fallible when social observations and decisions were involved. Second, we are talking about the very recent past; most of the faculty members who made these discriminary rules and adverse decisions about women are still in office. They probably wield even more influence now that they have attained greater seniority. The institutional structures and patterns of decision making they have put into place may still be producing effects that are no longer intended.

The patterns of financial aid awarded to male and female graduate students illustrate one such effect. Among students who earned doctorates in science and engineering fields in 1982, for example, equal proportions of men and women held university fellowships and teaching assistantships, according to a survey by the National Academy of Sciences. But for all fields combined, 31 percent of the men and only 19 percent of the women were primarily supported by research assistantships, and women had to make up most of the financial difference through their own efforts. If we examine this factor for individual fields, a curious relationship emerges. The fields that offer the most financial aid and thus require the smallest proportion of self-help, such as engineering and the physical sciences, have the lowest proportions of women. Conversely, those that offer the least financial aid and require the most self-help, such as psychology, social sciences, humanities, and education, have the highest proportions of women.

Should we therefore deduce that women students, already disadvantaged by their less affluent backgrounds and less distinguished alma maters, now compound their problems by deliberately choosing fields in which it is hard to find support as a graduate student? Or are women shunted, in one way or another, into fields where little support is available? We might also ask why it is that fields women and men consider equally important—as illustrated by their equal presence in them—deserve so much less public support than fields in which men predominate. Who laid down these rules and how were these priorities set?

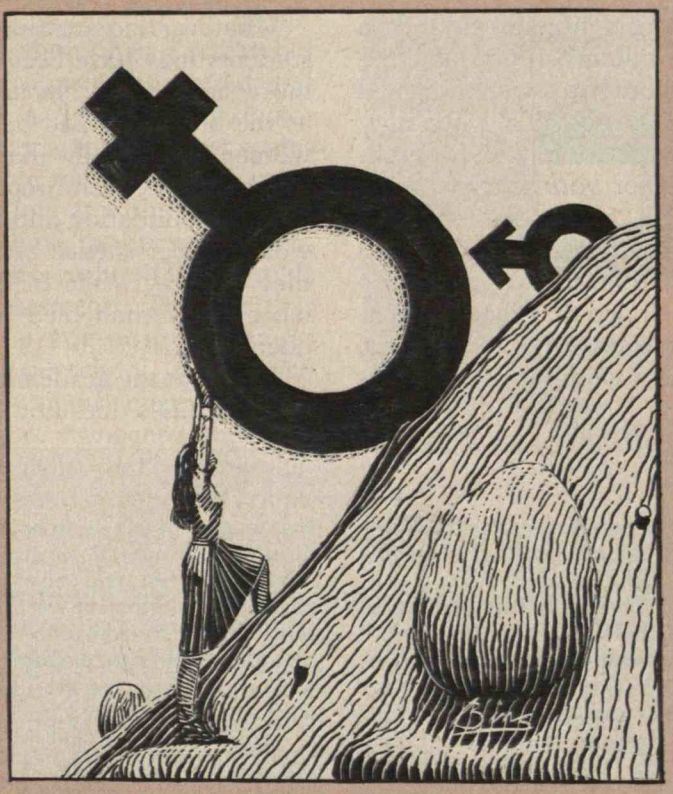
A more subtle but potentially serious sex difference in financial aid can be found in the allocations of teaching and research assistantships to men and women. Both forms of aid appear to require services of the recipient. But while the TA mainly performs chores for the department (although the teaching experience is useful), the RA does research that not only leads directly to a doctorate but also integrates the student into a research team and helps him or her to form a collegial network and foster closer contact with faculty. In general, research assistantships—much more than teaching assistantships—support the important process known as professional socialization. Yet in fields such as computer sciences, mathematics, and environmental sciences, male students reap the benefits of this process far more often than female students. For example, about 30 percent of the women but only 15 percent of the men who earned Ph.D.s in computer sciences in 1981 reported that their primary support in graduate school came from teaching assistantships. At the same time, 75 percent of the men but only 50 percent of the women reported holding research assistantships as their main source of income. Similar figures appear in environmental sciences, where about 15 percent of men and 25 percent of women principally hold TAs, while 60 percent of women versus about 80 percent of men hold RAs. In mathematics, the relative difference in TAs is smaller, with about 55 percent of men and 65 percent of women holding those appointments, but the difference in research appointments is large, with about 23 percent of women compared with 35 percent of men.

The Truth about Attrition

In the 1960s, the public controversy that surrounded the passage of equal-opportunity legislation produced many eloquent arguments to justify inferior treatment of women students on the ground that supporting their graduate studies was a waste of money. After all, the argument went, women students would eventually drop out to have babies. This particular bias was bolstered by a number of studies that showed far higher rates of attrition for women than for men. But while male dropout rates were

Women Working: A Field Report

BY H. PATRICIA HYNES



LOOKING back on my high school and college years, I realize now that I was fortunate. I was inspired by mathematics, not just a specific class or field but the whole continuum—arithmetic, algebra, geometry, calculus, probability, and statistical theory—and I moved in the company of women who were just as inspired. My instructors all were women and so were the other students. One of my teachers, Sister Bernice McGrory, consistently sent a winning team of students—among them myself—to the state mathematics competition. Scores of high-school students whom she taught went on to major in mathematics.

Attending women's schools had other advantages as well. Not once did I hear a sexually degrading comment in class, either toward or about any student. Not once did I witness the phenomenon of students' being expected to fail because we were women. What I am saying is that I grew up "breathing clean air": my first experiences with mathematics were uncontaminated by the "poisons" that infect so much of the science world.

Twelve years after finishing college, I entered graduate school in environmental engineering at a large public university. Two months into a course on dynamics in the civil engineering department, the professor introduced a new topic, renowned for its difficulty, with this anecdote: "Well, fellas, it's like the old saying about rape. You might as well lie down and enjoy it." The 30 male engineering students in the class roared with laughter. One minute later (it felt like one hour), I told the professor that his anecdote was degrading and offensive and that he should find another way to illustrate his point.

Later, this same professor began calling me "lovely Miss Hynes" whenever I entered his office to discuss an engineering problem. One day I was waiting for him with three young men from the class. I couldn't help but observe how cool and comfortable they were in his office, to the point of appropriating a work space in one corner and using his blackboard to discuss problems, even though he was not there.

When the professor walked in singing, "Lovely Miss Hynes, what can I do for you?" I replied, "Lovely Mr. Donovan was here before me." The aforementioned student turned beet red and stammered, "You go first." I sat down and tried to explain my questions about a specific dynamics problem. The professor began his answer with, "I always enjoy being next to a pretty woman." I heard myself say, "So do I."

By this point, I had been utterly distracted from the dynamics problem and its solution. I did poorly in that course because of this professor's campaign to undermine a woman determined to learn outside the degrading boundaries that some men force on women students.

On-the-Job Hazards

I now work as a senior engineer in the hazardous waste program of the Environmental Protection Agency (EPA). I am responsible for managing the study and cleanup of large, complex hazardous waste sites. This entails negotiating with corporations and ordering them to remedy pollution caused by their industrial-waste operations, as well as designing and overseeing the work of the agency's consulting engineers and scientists.

At the regional level, EPA officials enforce affirmative-action laws much more stringently than their counterparts in private industry or even universities. Supervisors are judged on how well they recruit and promote women and other minorities, and that judgment carries weight in their annual job review. Even so, I have experienced many of the usual occupational difficulties that women engineers face, such as being hired at a lower grade than men with comparable education and experience. Throughout my career, I have also watched men being groomed for management because of the perception that they have a "career" while women have only a "job." And I have observed that women do have to produce better work to be as visible as men and to be evaluated and rewarded equally. Numerous studies have documented such obvious examples of discrimination, so I prefer to discuss the more subtle ploys that men use to contain women within the domain of a domesticated and derivative existence.

When successful, this kind of behavior perpetuates the notion that the world of science is a world of heroic males forging ahead into nature's frontiers. Bright and intrepid women may enter and inhabit this world—but only as tenants to assist the male enterprise. A subtle example

PATRICIA HYNES is a senior environmental engineer for the Environmental Protection Agency in Boston. She is currently working on a book about Rachel Carson.

Women science faculty are twice as likely as men to be hired for positions without a future.

frequently ascribed to financial pressures—and in fact used to argue for more funding of graduate fellowships—high female dropout rates were assumed to result from lack of serious purpose. The possibility of a direct relationship between completion of graduate work and financial aid for *both* sexes was not even entertained until 1983, when the National Commission on Student Financial Assistance heard testimony on a likely association. In its spring 1984 report, the commission concluded that special attention must be paid to equalizing support patterns, although they failed to specify what form this attention should take.

Whatever the attrition rates of men and women students may have been in the past, they are much more similar now. In fields such as physics as well as the biological and behavioral sciences, men and women are equally likely to complete doctorates, according to several reports issued by the National Science Foundation and by CEEWISE. In chemistry, women's persistence rate is still only three-fourths that of men, while in engineering women are far more likely than men to persist until they obtain doctorates.

A look at the academic records of women who do obtain Ph.D.s does not support the contention that

WOMEN WORKING

Continued from p. 37

of such categorization is the way the distinguished French physicist Louis Leprince-Ringuet, in an article in *Réalités*, characterized Pierre Curie as a "creator" and a "genius" and Marie Curie as "patient, tenacious, and precise."

Every professional women has had the experience of being introduced or addressed without her title or by her first name, while men who are her professional peers are introduced with their titles or referred to by first and last names, or last name only. Another version of this ploy is to feminize or familiarize a woman's name. I have been addressed as "Patty" and as "my dear Patricia" by corporate managers with whom I am negotiating $20 million cleanups. My response is to turn it back on them; Jim, a company's chief of environmental operations, becomes "Jimmy," and Mr. Demorte, the firm's vice-president in charge of environmental affairs, becomes "my dear Ronald." What, on first hearing, may sound innocent and even friendly (maybe I remind someone of his sister or daughter) is actually an attempt to diminish my authority.

In his book *The Double Helix*, James Watson repeatedly refers to Rosalind Franklin by a nickname in an attempt to diminish her authority and dismiss her groundbreaking work on the structure of DNA. By calling her "Rosie" and describing her unfavorably, says Franklin's biographer, Ann Sayre, Watson was able to "conceal" Rosalind and construct in her place "an unattractive, dowdy, overbearing woman." For Watson, Franklin's major flaw was her insubordination; she refused to think of herself as Maurice Wilkins' assistant.

Paternalism Unmasked

Many men profess a desire to shelter and protect women. But what seems like a caring, paternalistic attitude is often an attempt to reduce women to reproductive beings in need of men's protection.

A few years ago, I was inspecting a pesticide-manufacturing plant that had polluted nearby groundwater, soil, and streams with highly toxic pesticide residues. During the inspection, the company's consultant attempted to distract me from the somewhat tense nature of my visit by telling me about his three young children and how much of a family man he was. As we entered an old and extremely dirty processing building, he advised me—with an air of pleased authority—that if I had plans to have any children, I might be concerned about inspecting the inside of this building. I replied that since *he* seemed to be the one intent on procreating, he should realize that his testes were just as susceptible to pesticides as my ovaries.

The rest of the inspection was permeated by an atmosphere of tense, perplexed silence. It was similar to the air of tension created when the female administrator of a federal health agency advised a group of men discussing occupational safety concerns that men working at Three Mile Island during the crisis really ought to be wearing lead-lined jock straps.

Scientists often objectify their subject, robbing it of vitality and spirit and replacing a passion for meaning with a psuedo-passion for data collection and static theory. (*See "Women and Basic Research: Respecting the Unexpected," page 44.*) Small wonder that science has failed to grip the imagination of most women and has caused many female scientists to reroute their intellectual passion away from research.

A particularly disturbing example of a scientist's distancing himself from his subject, and horrifying his audience in the process, was a lecture given in 1980 to an audience of engineers and scientists in Boston. A nationally known toxicologist, who was discussing the poisonous effects of various chemical compounds on humans, proceeded to stun the audience with larger-than-life pictures of thalidomide babies, emphasizing the clinical details of their deformities. At the same time, he bemoaned how difficult it was to do a valid statistical survey on the babies' mothers because these women were so "suggestible" that they could not be relied on to know if they had taken thalidomide or not. "Furthermore," he added dryly, "women don't know when they get pregnant." The clear inference was that these women were stupid yet necessary impediments to a very important and highly "objective" scientific study.

Continued on page 47

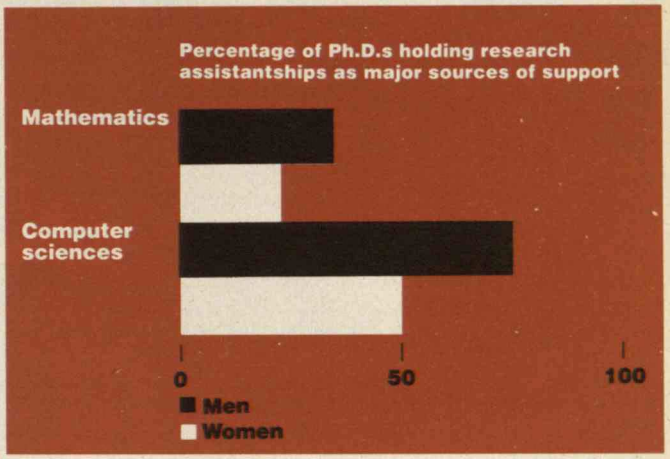
there are fewer women because they are not qualified. In 1965 Lindsay R. Harmon, then a researcher at the National Research Council, discovered that women who earned science and engineering doctorates had significantly better records and test scores in high school than their male counterparts. A more recent study by Jonathan Cole at Columbia found that those few women who have faculty positions in science and engineering possess higher IQs than male colleagues in the same departments. The fact that women maintain better grade-point averages through college and graduate school is also well known. These data probably signify merely that the women were selected by more stringent standards.

However, many scientists insist that better grades and test scores are not really valid measures of "quality" in science. After all, most teachers can recall students of apparently excellent ability who nevertheless lacked real spark. Therefore, scientists often use "proxy" or substitute measures of quality, such as the quality of the candidate's doctoral department, speed in completing the Ph.D., age, and plans for postdoctoral study or employment. Male and female Ph.D.s turn out to be virtually indistinguishable with respect to these variables, although there are occasional variations by field. For example, men are *older* than women by about one to one and a half years when they receive their degree in fields such as engineering, earth sciences, agricultural sciences, and economics. In mathematics, physics, psychology, and sociology, women and men are essentially the same age. The fact that men who receive their medical-sciences degrees are about three and a half years younger than their female counterparts can be attributed to those students, virtually all female, who pursued degrees in nursing. Little financial aid was available to these women at the time, and many needed work experience either to save money or to strengthen their credentials before embarking on graduate study. Even though marital status is often used to explain delays in graduate studies for women, recent studies have found no such correlation.

The Price of Harassment

Engineering is among the fields that exhibit the fastest growth in female participation. Women have increased their share of engineering baccalaureate degrees by a factor of ten in one decade (although the base from which they started was admittedly small). The first great push in this direction occurred in the early 1970s, when male engineering enrollments were dropping and faculty members had reason to worry about their jobs. Now that engineering enrollments are up and the shortage of engineers may soon turn into a glut, there is much less active recruitment of women students.

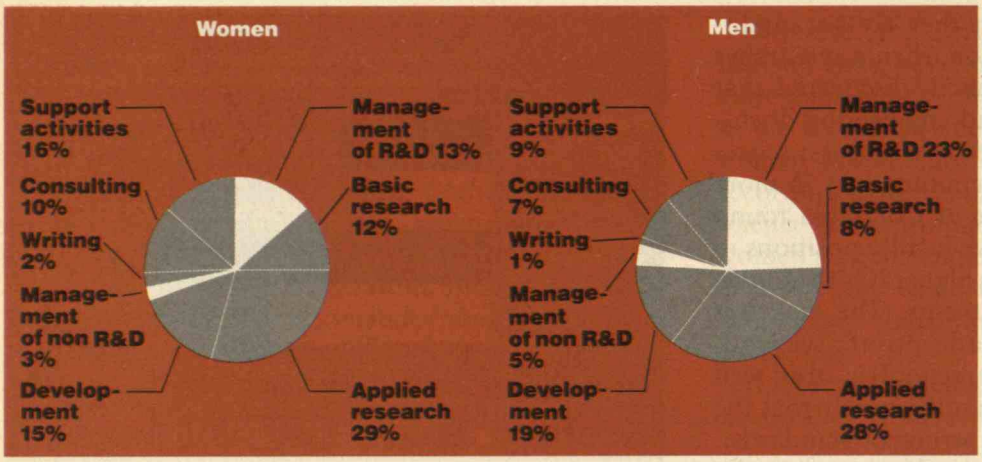
Male students are far more likely than female students to hold research assistantships in engineering and mathematics. Women hold more teaching assistantships. However, research posts provide more of a career boost. While TAs mainly perform chores for their department, RAs do research that leads directly to a Ph.D. and fosters close contact with faculty and peers.



Similarly rapid growth has occurred in computer science, where the proportion of women among recipients of bachelor's degrees has more than doubled, climbing from less than 13 percent to 30 percent between 1976 and 1980. However, the proportion who go on to earn doctorates in the field is only about half of what might be expected. A possible reason is the high incidence of sex discrimination and harassment of women students by male colleagues and faculty in this field. Women students in computer science at M.I.T. found this problem so pervasive that they organized a committee to deal with it and have written a very useful report on the topic. According to this report, published in February 1983, much of the harassment is performed on computers—in the form of obscene mail or printouts of nude women.

The women quoted in this report said they were treated not as valued colleagues but as objects of unwanted sexual attention. One female TA reported that a male student who had missed her lecture came up to her later and said, "Will you come sit on my lap sometime and tell me what I missed?" One woman was told by a secretary planning a summer technical meeting that the host of the meeting would prefer that female attendees wear two-piece bathing

DIAGRAMS: OMNIGRAPHICS



Left: Fewer women Ph.D.s are hired by industry, and those who do obtain employment are only half as likely as men to become managers. Conversely, women are almost twice as likely as men to be involved in support activities, such as performing library services, collecting data, and writing reports.

Right: These inequities show up in salaries. The median salaries of male scientists exceed those of their female colleagues by $4,000 to $8,000.

suits for swimming. The report, which also recommends how such attitudes can be changed, is now handed out to all incoming students and faculty in M.I.T.'s computer science department. As this and other studies have shown, the way women students are treated very much affects the extent of their participation.

Underrepresentation and discrimination are related in complex ways. When a young woman first considers her professional options—in high school or college—she is at a vulnerable time in her life, a time when society has trained her to be particularly sensitive to other people. It takes little discrimination, perhaps only one thoughtless remark by a teacher or counselor, to make her feel that an unorthodox choice of profession would be grossly inappropriate. After making the initial decision, she will continue to be sensitive to an inhospitable climate in classrooms and workplaces. Most people, female or male, are just not cut out to be pioneers, and the individuals who consistently find themselves chosen last when teams are picked usually go and find some other game to play. The attitudes that produce discrimination are not necessarily malevolent, but they do result in what Jonathan Cole has called "accumulative disadvantage"—the piling of one small disparity on another.

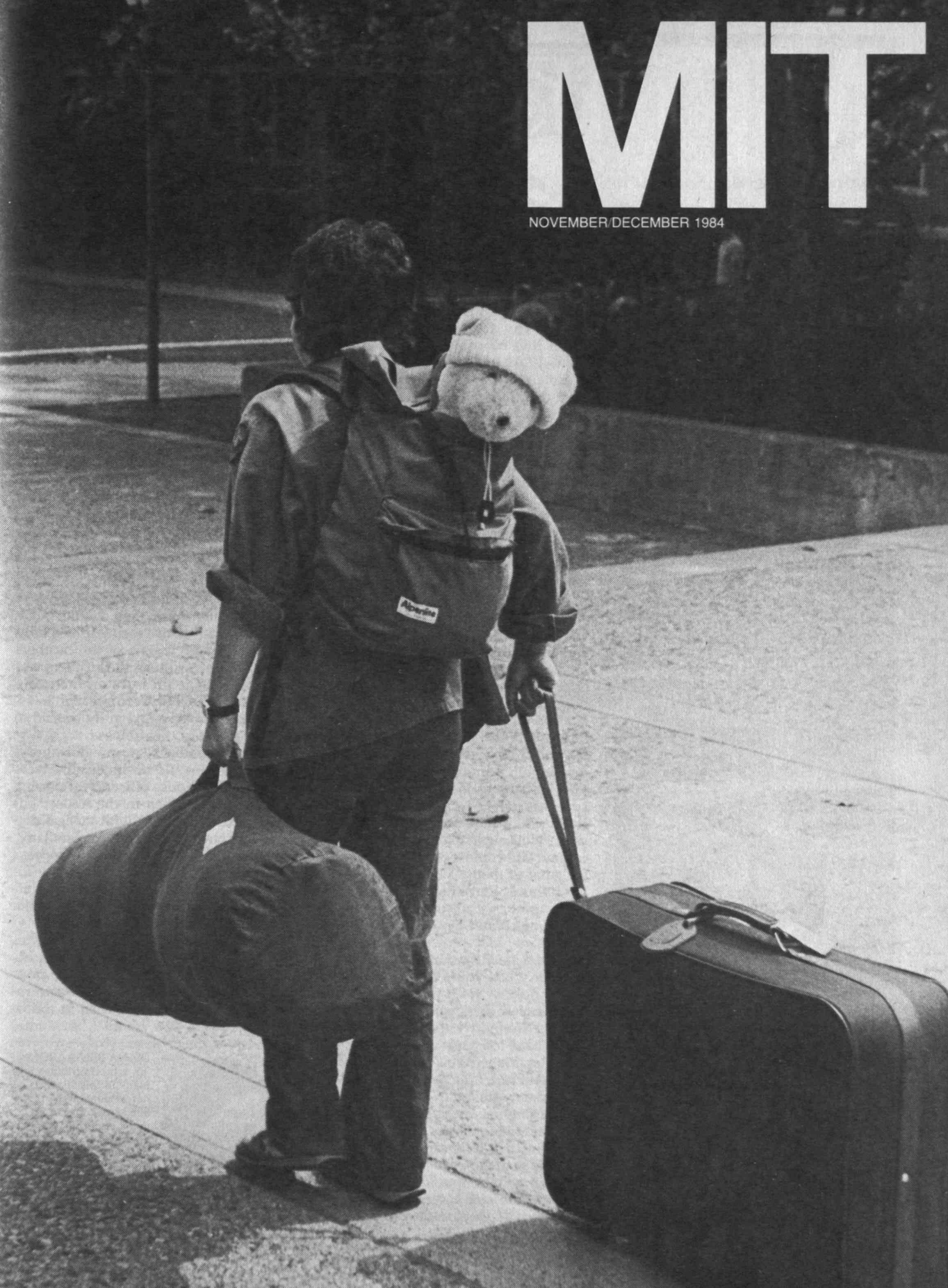
The Gender Gap in Jobs

Despite the many similarities between men and women Ph.D.s in the sciences, their prospects at the time of graduation for either a postdoctoral fellowship or for employment differ considerably. In reviewing the postgraduation plans of Ph.D.s in annual reports on doctorate recipients, the National Academy of Sciences noted that only with engineering fellowships do women have as good a chance as men of realizing their goals. In all other science fields, men are able to realize their plans for either employment or postdoctoral fellowships sooner than women. These results suggest a continuing strong preference by employers and senior faculty for men over women, regardless of qualifications.

Inequities in the early stages of professional life continue to dog the careers of women scientists. Among academic faculties, for example, men are far more likely than women to be hired for tenure-track positions, to be promoted to tenure, and to achieve full professorships. Meanwhile, women hold assistant professorships and nonfaculty positions more than twice as often as men. CEEWISE has found only small shifts in these distributions since 1977.

Why the discrepancy? A look at the 1970s, when colleges and universities sought to reduce their faculties and budgets because of an anticipated decline in enrollments while also observing the laws that prohibit sex discrimination, is revealing. Women were indeed hired, but mainly for the newly minted "revolving-door" or "folding-chair" appointments. Their presence in a variety of off-track, junior, and short-term positions has produced a superficial look of equality, quite without substance. In the 25 leading U.S. universities, women faculty in science and engineering are *twice* as likely as their male counterparts to be hired for positions without a future, according to the most recent report of the National Academy of Sciences' CEEWISE.

Such practices ensure that the essentially all-male image of leading science and engineering depart-



MIT

NOVEMBER/DECEMBER 1984

MIT

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ABOUT THE COVER

Our cover shows freshman Rachel Schleimer from New York City, who like her unidentified colleague above, is one of the 1,069 members of the Class of 1988 who arrived on campus on August 31. Selected from 6,055 final applicants, the class broke records with its 29 per cent women. It also included 66 black Americans, 26 Mexican Americans, 19 Puerto Ricans, one American Indian and 57 foreign nationals. Photo by Calvin Campbell.

DIANA BEN-AARON

Nothing in Their First 18 Years of Life Prepared Them For This

"We could assign living groups the way other schools do," said Kathy Chamberlain, '85, this year's R/O coordinator, to a crowd of about 1,200 new students, 700 upperclassmen, and a handful of faculty and administrators at this year's freshman picnic. "We could assign you a room and a roommate over the summer, and you could spend your first week of college sitting on one side of your pre-assigned dorm room studying your course catalog while your pre-assigned roommate sat on the other side of the room studying his course catalog.

"But we don't do it that way. We force you to deal with people before you start worrying about classes, and we force you to get to know each other before your classes together start. We could work everything out over the summer and make it easy for you this week, but in the long run it would not make it easier for you. . . . R/O is M.I.T. at its best. Enjoy it while you can."

A standing ovation from the student R/O committee for Kathy, a standing ovation from everyone in Killian Court for outgoing director of admissions Peter H. Richardson, '48, and five more speeches later, Intrafraternity Council Rush Chairman Tom Schmitter, '86, said: "Nothing in the first eighteen years of your life could possibly prepare you for what is about to happen in the next ten minutes. Let the Rush begin!"

Handbook Can't Do Justice to Rush

I heard a freshwoman say anxiously to another, "Did you read your Freshman Handbook?" "Yes," said her classmate. "Cover to cover?" said the first. "Yes," said the second. "I never looked at mine and I have no idea what's going on," said the first. "Well, neither do I, so don't feel bad," the other reassured her. A moment later, they had disappeared as fraternity members armed with signs, banners, megaphones, and in one case a carnival barker's podium stampeded into the court to grab the apprehensive freshmen. We upperclassmen moved up onto the small rises at the sides of the lawn. "I wouldn't go through R/O again for anything," commented one of our number.

I felt the same way. Even as a freshman, I was convinced that upperclassmen were enjoying the round of parties and tours much more than we were. For them, it was an excuse to organize and attend parties and tours; for us, it was a desperate gamble.

Two days after this year's freshman picnic, I went with some friends to a fraternity. The rush chairman met us at the door with the harried expression of one with miles to go and hundreds of names, hometowns, and prospective majors to assimilate before he sleeps. His first problem was to separate the freshmen who traveled in packs; one or two brothers would try to get to know each freshman and then would begin the arduous task of "seeing if he's right for the house," as one of the brothers put it. The pressure on the brothers was nothing like the pressure on the freshmen—after all, they were already "in"—but the brothers could hardly be said to be free to enjoy themselves.

Meanwhile, back at my dormitory, upperclassmen and freshmen alike were relaxing. The house officers were trying to interest freshmen in the house, but they weren't doing it with tactical diagrams. They didn't have to. Similarly, the freshmen were not trying to impress the upperclassmen. They didn't have to. Nothing could affect the housing lottery, so everyone concentrated on the events at hand.

There is a noticeable difference in intensity between rush at a fraternity, activity, or freshmen academic program—whose life depends on its ability to recruit warm bodies—and rush in a dor-

DIANA BEN-AARON, '85, who contributes regularly in this space, is editor-in-chief of *The Tech*. She is majoring in humanities and materials science.

mitory—whose continued existence is assured because it will be assigned its quota of freshmen anyway.

Does this mean R/O is held solely for the benefit of the fraternities? I thought so until I heard Kathy explain why M.I.T. forces students to choose their own living groups. It is for the freshmen and for living groups to showcase their infinite variety: from the chocolate orgy at Burton to the Russian Absurdist Literature storytelling at Senior House.

Torchlight Parade to *'The Social Beaver'*

In any case, there has always been some kind of fete to welcome each new class at M.I.T. In 1884, there was a torchlight parade; in 1909, a Field Day consisting of football, relay, and tug-of-war. Fifty years ago, freshmen were whisked off to a three-day camp the instant they arrived at M.I.T. and honored with "smokers" (dinners with cigars handed out afterward) upon their return. In 1959, new students were treated to science lectures and showings of the movie *The Social Beaver*.

In recent years R/O has consisted of a sequence of set events beginning with the freshman picnic and ending with the president's reception, all run almost entirely by undergraduates. A committee of thirty work through the summer to plan the ten crowded days freshmen will remember forever. Some 250 students return early to help them, and the Institute put the entire physical plant and a $15,000 budget at their disposal. That is only the money from the Dean for Student Affairs. Probably $100,000 total, counting living group and activity funds, is spent during R/O. "M.I.T. could never do it without you," Kathy Chamberlain told the R/O workers. "It couldn't afford it."

A new effort to orient and brief new students on what R/O Week will be like was made this year when M.I.T. separated them into groups of 35 with an upperclassman and an administration leader for pre-picnic discussion groups. (But all attempts at description, except to say R/O Week feels like being shot out of a cannon, must fail, because there is nothing like R/O Week and everyone has a different R/O Week story.)

At the discussion group I helped run, I asked the freshmen why they came to M.I.T. Many were attracted by the Institute's reputation, either as a "good school" generally or in a specific field, most often engineering. Some came to M.I.T. because they felt it would challenge them in a way no other school could. One student said, "I wanted to see what a $16,000 education felt like." ("$60,000," said Dean Leo Osgood, my faculty counterpart in this discussion, "—a $60,000 education.")

At last one can understand folks who spent high school on the burnout bench.

Another said, "Because it's cheap," but there were few laughs. It is no small thing to assume the triple burden of loans, term-time jobs, and encroaching on family income to come to M.I.T. in the first place, and as tuition rises it becomes more and more difficult for us to justify the staggering bills to ourselves.

A Trek Over the Rooftops

On a hacking tour during R/O Week, a freshwoman told me, quite seriously, that there is no hunger in America. "What about migrant workers? What about Appalachia? There are dirt-poor areas of this country; just because you can't see it here doesn't mean it doesn't exist," I said. If I had been thinking, I would have mentioned the homeless people of Boston Common or the woman in Kendall Square whose children hadn't eaten in three days.

"But there is so much opportunity," said the freshwoman, her eyes wide. "You can do anything you want. All it takes is hard work, not handouts. I don't agree with the welfare system at all."

I should have asked her where she thought welfare mothers were going to acquire job skills, but a trek over the rooftops of the Institute isn't really conducive to an extended political discussion.

By the end of the year, she and everyone else at M.I.T. will have known despair. This can be an oppressive environment academically, financially, and spiritually. A sophomore once wrote in a graffiti book, "This term, for the first time in my life after 13 years of school, I will not pass all my courses." Someone else wrote back, "A neat feeling, isn't it? At last one can understand all the folks who spent high school on the burnout bench." If four years at M.I.T. can teach the Class of 1988 compassion as well as differential equations, their time will be well spent. If, on the other hand, they are seduced by the "opportunity" of R/O Week into believing M.I.T. is always at its best, it may be that they might have learned more from a school that hands out dorm assignments over the summer. □

ILLUSTRATION: ELIZABETH SLOTE


SIGMA CHI
fiji
Lambda
Alpha

Expensive and Exhilarating, Rush is Fraternities' Most Vital Investment

TEXT AND PHOTOGRAPHS BY
DONALD M. DAVIDOFF, '86

Rush:
1. To lavish attentions on, as in courting; to entertain prior to inviting to join a fraternity. 2. To move or go swiftly or impetuously.

Perhaps nothing I can say about Rush better sums up its style and meaning than these dictionary definitions.

Rush is fast-paced. In the period of 72 to 96 hours, more than 1100 freshmen and transfer students visit 33 independent living groups and 14 dormitories, and they choose where to live. With special dispensation from the brothers (I'm not a member), I spent those four days at Sigma Chi last fall to get an inside view of how Rush works.

Rush builds slowly during the summer for fraternities. Brochures are mailed to incoming freshmen, and brothers of the house are given lists of freshmen males to call and/or write. Parties or picnics are thrown in many areas outside Cambridge to establish contacts before Rush starts on campus.

Then comes Work Week, which, contrary to popular belief, is not wholly separate from Rush. "Sure, Work Week is a time for fixing up the house and making major repairs," Stephen Chamberlin, III, '85, the Sigma Chi Work Week Manager, told me. But even more important, it's a time to get people back together—"you get reacquainted."

Stephen put a lot of time into Work Week, spending an average of two nights a week for most of the summer planning projects, ordering materials, etc., and then the entire ten days prior to August 25 outlining specific jobs for the week. Aside from the standard painting and cleaning jobs, Sigma Chi installed new bed lofts, new curtains, and new carpet and replaced some damaged floors.

Once the freshmen arrive on campus Rush rules forbid upperclassmen from discussing fraternities until after the R/O picnic, this year on Friday, August 31. Fraternity members canvass the picnic grounds to identify their candidates, but no one is allowed to show house colors until the end of the picnic speeches, when the Interfraternity Council chairman coordinator commands, "Let the Rush begin." At this time, all house members sprint towards the nearest freshman. After shaking hands, each brother points his freshman toward his house's sign at the back of the grounds and heads off for other quarry.

Rush is More than a Party

Some houses have special events that include first-year women, but not Sigma Chi. "Rush isn't a party," says Sigma Chi Rush Chairman John Martin "It's a time to choose where to live. Women aren't going to live here, and we just don't have the manpower to have activities for them."

Friday night is just a narrowing-down process. If a prospect is liked by even a few members, he'll be encouraged to stay around to win more friends. As one brother said, "Friday night you get the bodies, take a quick look at them, and decide if you want to see more of them. If so, you invite them to stay the night."

Saturday is a trip day. The Sigs went to the beach to relax, eat, and play frisbee. "You can tell a lot about a guy's personality by how he plays sports," said one participant in the Rushing process. It is important for the house to get people on the trip. Aside from keeping them away from other houses for five hours, the trip lets the brothers have longer, more intimate conversations.

Saturday night is a big dinner night—very busy. The period before that, however, is usually a lull when the brothers can catch a few Z's. "Then when the food comes, the freshmen come in like flies," Steve Chamberlin told me; and they did. Many fraternities follow dinner with a mega-party, but for Sigma Chi, it was low key—a coffeehouse with folk singing.

Strategy Decisions in the "Backroom"

Sunday is the day most bids go out, and again there is a big trip, designed to both get the freshmen away from other houses that may be cross-rushing and sell them on Sigma Chi. Bids given out must be kept open until Friday, but Sigma Chi will keep its bid open for a student's entire four years.

The Rush Chairman spends most of the weekend in the "backroom." This is where all voting on prospects is done. The brothers will talk to one or two freshmen, then come back to the room and record their impressions on each freshman's voting sheet. It is the chairman's responsibility to keep likely prospects around the house. It is also his responsibility to "flush" those that are getting low marks.

Flushes at Sigma Chi were done with great care by a brother who has had experience doing it before. In general, the house never flushes anybody without calling other houses to locate at least one the prospective pledge should try. Even a late flush does not spell the end for a freshman. In fact, one freshman walked through Sigma Chi's doors on Sunday morning after being flushed by another house. Within 12 hours, the brothers decided they wanted to give him a bid.

The backroom is also the scene for most of the strategy discussion. Strategic decisions depend on the style of the fraternity. Some fraternites apply pressure on those freshmen being cross-rushed as a means of keeping them around, others don't. At Sigma Chi, the general trend was to keep the freshmen so busy talking or doing something that they would forget about other houses. The approach was mellow, and it seemed to work most of the time. But

PHOTO: JAMES H. HILBING, '86

Friday night you get the bodies, take a quick look at them, and decide if you want to see more of them.

not always: Sigma Chi was the victim of a "big suck," a term used when another fraternity convinces a good prospect to stay around its house most of the weekend. This freshman ended up being pledged before the Sigs ever got a chance to bid him. Likewise, I'm sure, at least one of the Sigs' biddees was sucked off from another fraternity.

Women in Rush

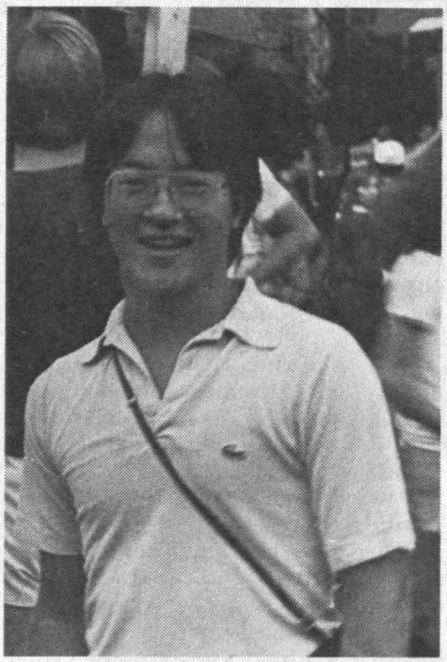
Lianna Cleland, '86, is a junior in Course III. She is what Sigma Chi terms a "friend of the house," the equivalent of what many fraternities call "little sisters"—girl friends of members and other women who are familiar with the house and its life.

During Rush this year, Sigma Chi had about ten such friends of the house, women studying at M.I.T., Wellesley, Simmons, or other colleges.

Aside from helping with the day-to-day jobs in order to free the brothers to talk to freshmen, the friends themselves meet and talk to prospects and then contribute to the discussions in the backroom. "The brothers like to see how prospects react with women," notes Lianna. "Some guys will open up to girl better than a guy. You want to give the freshman all kinds of people to talk to." She looks for sincerity in a freshman. "You know whether or not you get along with somebody."

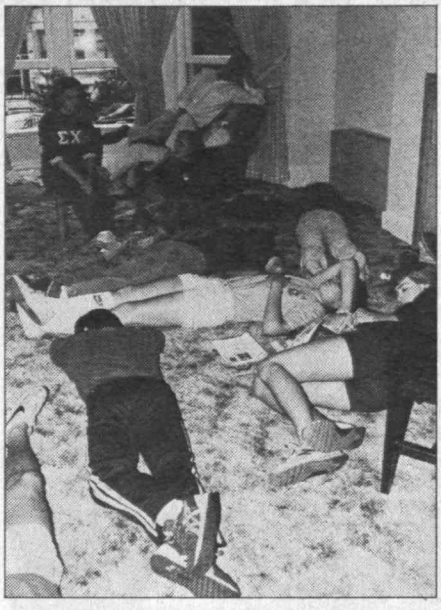
Lianna became involved with Sigma Chi through a member she knew in high school. "I come from the South, and fraternities are a way of life down there. I sort of expected to become involved with one."

All in all, the chronology of events, the systems, and the strategies make Rush not only a very fast-paced event but also a very exciting one. Whether or not one feels that M.I.T. Rush is good for the community or not, one has to admit that it works: all but 10 males in the Class of 1988 visited at least one fraternity during the weekend, and 260 (out of a class of 760) are now living in fraternities, including 8 at Sigma Chi. Not a bad three day's work.



The Rush scene at Sigma Chi (clockwise from top): ☐ Peter Warren, '87, in a typical pose of collapse. ☐ Erwin Su, '87, the man in charge of sleeping arrangements. ☐ Brian Hirano, '87 and Rob Sabo, '86, work hard at getting to know freshmen. ☐ And Mark Curtiss, '87 and Rachel Hoffman, a brother and a "friend of the house," welcome potential pledges.

Chronicle of Exhaustion



Thursday

9 A.M.•I arrive to find the Sigma Chi house incredibly trashed. The remains of days of renovations are strewn all over the place, and it is hard to walk anywhere without wading through rubble. At the moment the only people awake are Ed Schembor and Erwin Su, the morning cooks. They are diligently cooking eggs and bacon (Ed tells me they both have been McDonald's cooks). The house had been up until three the previous morning finishing up the major projects. They tell me that most of what's left is cleanup.

2 P.M.•Peter Ulrich and I just finished cutting and putting down a new carpet. Brock Sullivan hung out of windows three stories up to clean them. The bathrooms were cleaned, and David Pehlke just finished fixing a broken toilet. Work Week is definitely a tough time. Literally everything is taken out, cleaned and/or fixed, and put back.

11:45 P.M.•It was hours ago that I had dinner with John Martin at Dino's Pizza after a reasonably boring Rush Chairman's Meeting. (The word is that there are significantly fewer male freshman this year, so Rush will be tight.) I had a relaxing talk with Jeremy Verba on the balcony of the fourth floor. I'm told it's a favorite spot among the brothers to vegetate. Work Week has the brothers really keyed up for Rush. Everyone is dead tired, but I still hear animated conversations as they work on. I just finished mopping the third floor; I'm hot, sweaty, tired, and I feel like a pile of garbage. But somehow I'll have to find more adrenaline to keep up with these guys. They still have much to do.

Friday

12:30 P.M.•I just awoke to find that the morning had consisted of still more cleanup and last-minute fixing. The backroom is set up and the phone lines are in place. The friends of the house were just briefed on the weekend's schedule and reminded about Sigma Chi's style of Rush—low-key, no pressure. The brothers are about to get their briefing. It definitely feels like the lull before the storm.

6:30 P.M.•The picnic across the river is finishing up, and the first arrival at the Sigma Chi house is due within minutes. I hear a few laughs and casual conversation. Looking around at the immaculate surroundings, it's difficult to imagine this is the same place I came into yesterday.

7:45 P.M.•The house is filling up with freshmen, and the backroom is a madhouse. People are running in, talking, voting on freshmen, and running out. John Piotti, '83, asked one of the friends of the house to call a prospect at Delta Upsilon and convince him to stop by. It's very fast-paced, but considering the seriousness of it all, it is also quite lighthearted.

8 A.M.•The house has settled into a pretty steady hum of activity. Approximately 25 freshmen have found their way through the doors. The Clearinghouse computer, which keeps track of where all freshmen are and how to call them, is down right now, so it is impossible for Sigma Chi to get hold of any summer rush prospects who aren't already here. It is hot and muggy in the backroom—very uncomfortable for those workers forced to stay there.

8:30 P.M.•More of the same. The flow of people is slowing. There are a lot of smiling, eating faces. Brothers are running about chatting with people. One freshman in from DU was about to leave, but John Martin sent someone to invite him to stay overnight. The basic order of the day seems to be to keep the brothers circulating as much as possible and to keep all prospects.

9 P.M.•Clearinghouse is finally up. Invitations for staying overnight are going out to many. More than 40 freshman have come through, and there are only two or three obvious flushes. It seems like a form of organized confusion.

9:40 P.M.•The first viewing of the slide show just ended. It was impressive, with three projectors and accompanying words and music. It stressed the major activities, fraternalness, and individuality of the brotherhood. It was very hot in the barroom where it was shown. I can't believe it is only 9:40.

10:20 P.M.•I never realized how many stairs are in this place (127 I'm told). You really notice them as you get tired. Approximately 15 freshmen will stay the night.

10:45 P.M.•My eyes are drooping and my stomach hurts. Saturday beach trip invitations are going out, and the overnights are continuing to shape out.

11 P.M.•The crowd is beginning to thin down a bit. Erwin Su is running around setting up night arrangements, which entails not only getting rooms but also getting the prospects across the river to pick up their clothes. Conversations with the brothers are getting longer and more intimate, and there are fewer new arrivals.

Midnight•It is not quite as exciting as before. More brothers are relaxing somewhere for a few minutes. I crashed for about 30 minutes myself, but I still feel dead. More invitations, continual voting on prospects.

1:00 A.M.•Everyone is hanging out in the library and working on getting rides for people to other fraternities or across the river for their stuff. Su is running about like a chicken with his head cut off trying to coordinate all this. John Martin is trying to get brothers to talk quickly to two newcomers, so he can

Rushing freshmen is like being a nurse in a cancer ward, you have to be friendly, but you can't get too close to anybody.

determine what to do with them for the night.

1:30 A.M.•The push is on to get the freshmen to bed or out of the house. Just the thought of sleep in an hour makes me feel better, and the brothers seem more alive.

2 A.M.•Meeting in the music room for brothers and friends of the house. The meeting lasts about 45 minutes, limited to reviewing the day's events, discussion of those freshmen currently in the house, and strategy for getting prospects not staying over to drop in tomorrow.

Saturday

8 A.M.•Brothers are trying to contact summer prospects who have not come by yet and some freshmen who were seen and liked but did not stay over.

10 A.M.•Breakfast of eggs, sausage, bacon, french toast, and juice (brothers and freshmen alike eat well). The work of the moment is to vote on new guys and try to fill up the beach trip. Nothing is too serious at the moment, and all the options are open on most freshmen.

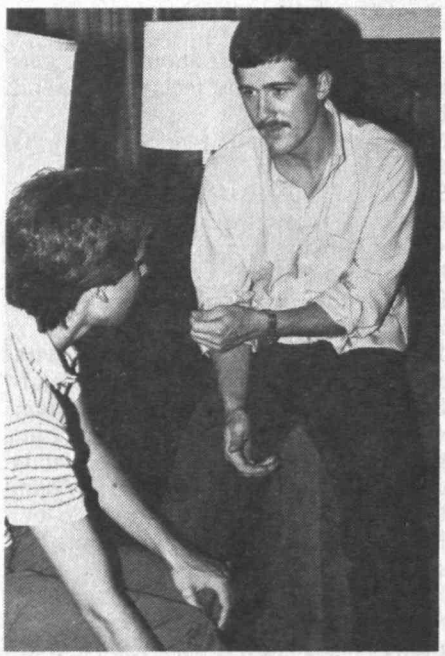
10:45 A.M.•It is an informal atmosphere now. Brothers are playing backgammon or talking with those now in the house.

2 P.M.•A frisbee game is underway at the beach. As Brandt said, "This is a more relaxed setting, more natural," although there is still a heavy undertone of Rush as the brothers form occasional small groups to discuss prospects. Overall, this phase is much more fun.

6 P.M.•Back at the house, I crashed for almost an hour. People are looking quite tired, and they seem to be taking advantage of the pre-dinner lull. The most strenuous activity is a game of cribbage between a brother and a freshman.

7 P.M.•Dinner for the brothers and the 15 freshmen currently in the house is about to begin. The backroom is very busy trying to dig up one or two remaining invitees. There is a problem with losing frosh—not to other houses but rather to the dormitories, where they are harder to locate.

8 P.M.•The dinner of roast turkey, vegetables, salad, pecan pie, and ice cream was fabulous. There was no chance that anyone would go hungry. I am stuffed! Four brothers waited on tables and two helped the cook. Plenty of time is being spent on top prospects who are being seriously cross-rushed, though hard pressure is never applied here. Some tough decisions are being made, and one prospect was flushed after receiving two blackballs.



(Top to bottom, above): □ Debbie Salvucci, the Sigma Chi Sweetheart, sang for hours at a coffeehouse. □ Steve Chamberlain, '85, making a persuasive case for fraternity life. (Top to bottom, facing page): □ Sigma Chi gathers on Beacon St. to welcome the first pledge of 1984; □ summoned by Jeremy Verba, '86, striking the pledge bell. □ Lianna Cleland, '86, and Saroja Raman are among the friends of the house.

8:50 P.M.•Debbie Salvucci, the Sigma Chi Sweetheart, is playing her guitar and singing at the library coffeehouse. She's playing mostly folk songs: Simon and Garfunkel, Harry Chapin, Bob Dylan, etc. She is very good, and the mood she's setting is mellow and relaxing. This is in stark contrast to the loud parties I can hear going on down the street. I see lots of smiling faces and animated but light conversation. So far, this is my favorite time. It's just a chance to meet the brothers and take it easy.

9:10 P.M.•Another flush, after phone calls to ensure he'd be welcomed at another fraternity.

12:30 A.M.•The coffeehouse has thinned out. Those left are singing along. Erwin is again starting to work on overnight arrangements. It has been a long hard day for the brothers, and they all face decisions soon—bids go out tomorrow.

1 A.M.•All of the freshmen are in bed except for one. Debbie is still playing, and the brothers are resting and singing along. Tonight's meeting, where many bid decisions will be made, will start fairly soon.

Sunday

8 A.M.•I just woke up. I feel tired and grubby. I can't believe I've only been here 72 hours. It feels more like a week.

9:30 A.M.•The first bid session just finished.

11:45 A.M.•The house is quite empty now. Most people are out on unstructured activities one-on-one with the most likely prospects. There is only one new freshman, a flush from another fraternity, and Martin and Piotti are talking with him. Four bids are now out.

Some guys will open up to a girl better than a guy. You want to give a freshman all kinds of people to talk to.

1:30 P.M.•Says one Sigma Chi brother: "Rushing freshman is like being a nurse in a cancer ward. You have to be friendly, but you can't get too close to anybody."

1:35 P.M.•Bid number five given out. It's very quiet and relaxed here at the moment. Most brothers are out of the house, and a number are resting and playing Trivial Pursuit. Emerson College students are moving in next door, so it's noisy. The brothers are selling themselves to the biddees as much as evaluating those prospects still left without bids.

8 P.M.•At Jim Sturdy's house in Cohasset, Sigma Chi is putting on a dinner of steak and lobster with clams, salad, and all the fixings. The environment seems a lot like what a house trip during the term must be. On the way here we played ultimate frisbee, football, and soccer at Cohasset High School. One brother flew his radio-controlled airplane. Activity is high and morale and interest are up.

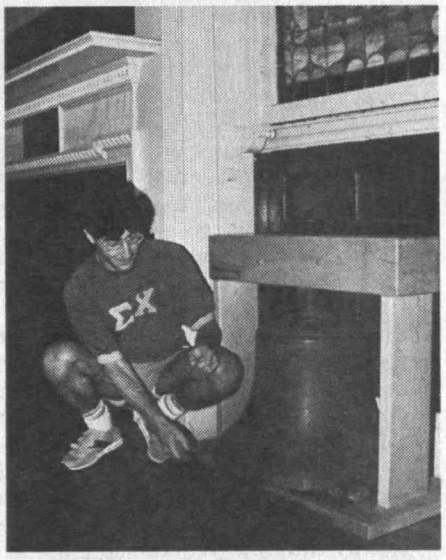
11:00 P.M.•The ride back to the house was a good chance to sleep. Nine bids are now out. The order of the moment is to sell Sigma Chi to the freshmen instead of the other way around (my, how quickly the shoe switches feet). Most people are here in the music room, playing backgammon and the like.

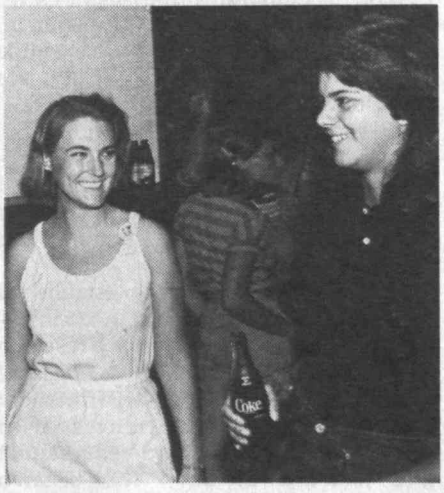
11:45 P.M.•You can hear the music from a band party from down the street, but the mood here is much more quiet and soft-sell. The backroom is busy trying to guess who will pledge. Two freshmen have been shown the door because the numbers just didn't work in their favor.

Monday

8:15 A.M.•FIRST PLEDGE. Ironically, the first pledge was the freshman who only 24 hours ago walked in the door after being flushed from another fraternity. The bell rang, people yelled "Pledge!" and ran outside to form a huge circle in the street, sang "Dear Brothers," and presented the new house member with a shirt.

9:50 A.M.•Pledge No. 2. We were told to follow Rakesh Shukla, a brother in the house. We ran around the entire block until he led us back in the house and upstairs to the pledge, whereupon Rakesh was properly showered for his prank.





10:30 A.M.•Pledge No. 3. Everybody was pretty dead around the house, but when the bell rang they all jumped up and came alive.

10:55 A.M.•No. 4 outside in the rain. The house is much more festive now. Cries of "One, two, three, four, we want five."

11:20 A.M.•No. 5 on the Harvard Bridge. Other brothers from other houses are running about for their own pledges, so it's confusing. Apparently one of the new Sigma Chi pledges found his way into the Sig Ep annex trying to chase down this pledge.

12:20 P.M.•No. 6 pledged inside the Kenmore Square T-station. We are about to leave on the road rally.

No more pledges came before I left on Monday night. The day had been festive to say the least. Each new pledge was a new hit of adrenaline to each brother. Of the remaining three bids, one pledged Tuesday morning, one was lost to another fraternity, and the last one pledged Wednesday afternoon. The last pledge, as is Sigma Chi tradition, was made inside the showers of neighboring Phi Kappa Sigma fraternity.

Eight pledges was their goal for 1984-85. Then in December, Sigma Chi will elect the new Rush chairman, and the cycle will begin again.

DONALD M. DAVIDOFF, '86, is a double major in aeronautics and astronautics and history and a frequent contributor to Technique. *This first-person account of Rush as viewed from inside a fraternity was written for* Technology Review *with the cooperation of the M.I.T. Chapter of Sigma Chi. This chapter was honored by the Sigma Chi International Fraternity for its generally outstanding performance and for its scholarship program in 1983-84.*

M.I.T.'s Unique Program Endures Because It Pleases All of the People All of the Time

Paul Gray, '54, once said that one of the wisest things he ever did as an administrator was to hire Margaret MacVicar, '65 to set up the Undergraduate Research Opportunities Program and give her "a very long leash." Now that UROP is a 15-year old runaway success, that remark may sound more like an amusing compliment than a statement of fact. But it serves as a reminder that UROP was anything but a sure thing when it was established in 1969, and that as a new associate provost Gray was taking a gamble.

To quote the president's report on the tenth anniversary of UROP:

"It . . . began at a time of unprecedented ferment and deep discontent at M.I.T. and on campuses throughout the nation. In the midst of this, M.I.T. invited its undergraduates to come into campus research pursuits as full, contributory citizens. It was a bold move against a swift current of development that had followed the massive World War II research efforts—a development which converted several leading universities into world class research institutions at the price of orienting faculties toward graduate and postdoctoral education with such intensity that undergraduates were effectively disenfranchised from the mainstream of intellectual action."

That bold move was led by a very junior faculty member: in '69 MacVicar's doctorate in materials science and metallurgy was only two years old. There was some question whether her more established colleagues would take her seriously enough to welcome undergraduates into their laboratories.

What the program had in its favor was a strong commitment from many administrators and a grant from Edwin H. Land, founder of the Polaroid Corp. (It was Land's 1957 lecture on the need for M.I.T. to foster individual creativity among even its youngest students which kindled the concept of UROP.) The program also commanded the attentions of the departmental UROP coordinators MacVicar enlisted and of the group of 25 to 40 students, faculty and administrators, different each year, that met with the president, provost, or chancellor each semester of UROP's first decade. This assembly thrashed out the minimalist operating procedures that proved to be the genius of UROP.

"A Whole New Toybox of Colleagues"

Everyone from the *New York Times* to Stanford University has taken note of the program's success: UROP now involves approximately 60 percent of the faculty and three quarters of the undergraduates each year in research projects which have spawned patents, publications, seminars, and other public presentations—while winning enthusiastic support from its participants.

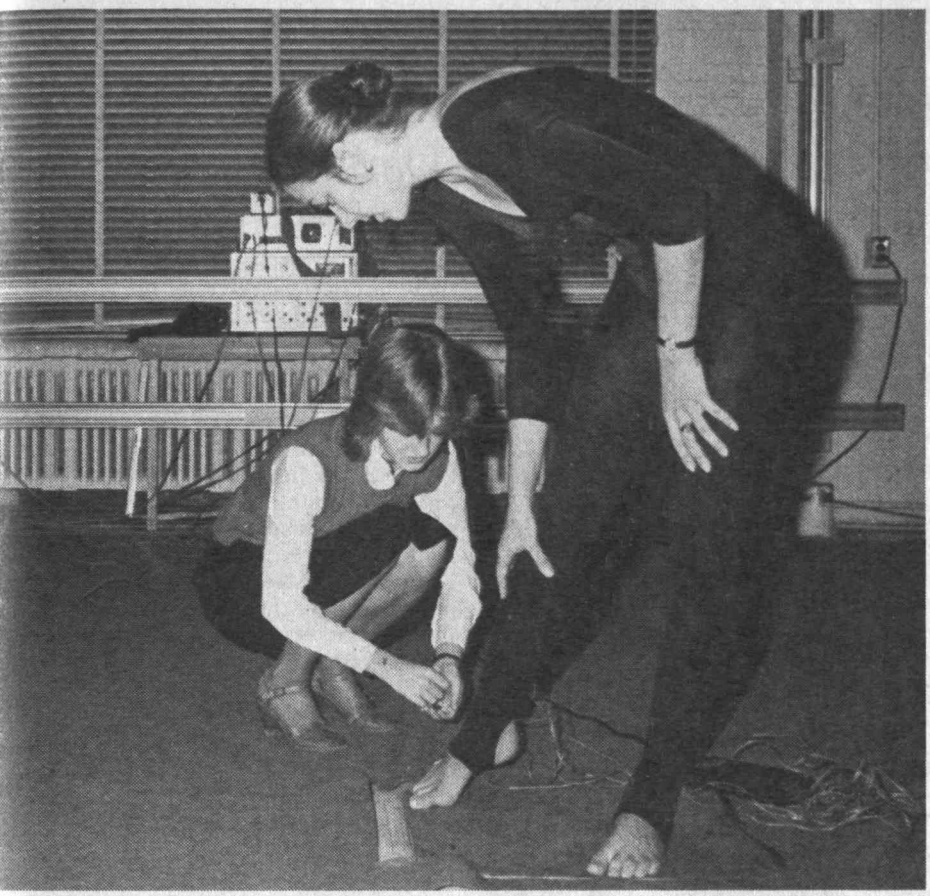
All the well-deserved attention focused on the achievements and satisfaction of UROP students over the years has tended to overshadow what President Gray thinks is one of the key reasons for the program's continued success: it has been a boon as much for the faculty as for the students.

MacVicar vigorously agrees with that assessment: "UROP gives the faculty a whole new toybox of colleagues," she says, and puts their relationships with the students on a more rewarding footing. In the classroom, the newness and discovery are for the student alone; in the laboratory, MacVicar points out, the professor and the student share them.

John E. Edmond, professor of earth, atmospheric, and planetary science, provides perhaps the definitive example of how UROP works for faculty. He came to M.I.T. in 1970 with a new doctorate from the Scripps Institution of Oceangraphy at the University of California. A water chemist, "barefoot and bearded," he recounts, he found himself in command of an empty laboratory and $20,000.

At that time there was no established pool of graduate students in oceanography to help Edmond launch a research effort. He credits Frank Press, head of what was then called the Department of Earth and Planetary Sciences, with going to MacVicar with a request that she "look after my boy." Thus began a

(Above, left) Research means you do whatever the project requires, like pounding a steel coring tube into a salt marsh. Ray Schmitt '86 is the UROPer studying marsh hydrology.



Linda Wormley, '85, adjusts the light emitting diodes (LEDS) that will enable her to record and analyze the movements of graduate student and dancer Claire Welty, part of an effort to understand the origins of dance injuries. Begun as a UROP project, her study will continue as a senior thesis.

long-term research effort driven very significantly by undergraduates.

"We started doing very cheap things," Edmond recalls. "We started looking at the processes that control the chemistry of natural water in Massachusetts. . . . It was great fun, and it turned out to be very important research. A paper published in 1973 (on pollution in the watershed of New Hampshire's Merrimac River) was written almost entirely by UROP people. It is now the standard in the field."

Edmond did some of the first work on the east coast on acid rain with undergraduates, who maintained a 24-hour rain sampling operation on the roof of the Green Building, among other things.

Four or five student UROPers have worked with Edmond in typical years, and there have been bumper crops during years when special NSF funding for undergraduates was available. As a result, there are now some 100 "alumni" of Edmond's UROP projects.

Edmond's ability to compensate students has increased as his laboratory has grown. Now that he manages $300,000 to $400,000 in annual research funding, Edmond can offer UROP students academic credit or salary and can guarantee summer jobs for those who want them.

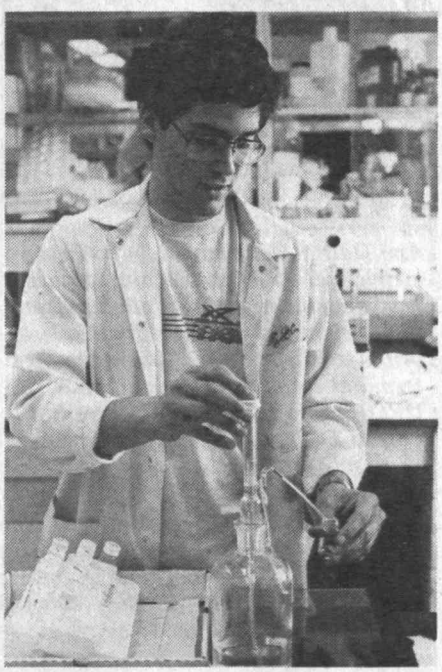
One UROPer is on Princeton Faculty

"There is a peculiar personal satisfaction for a faculty member who's been involved in a relatively large way," Edmond says. "You almost become your own little college," recreating the tutorial atmosphere of Oxford and Cambridge. "Some of these students spend several years in my laboratory. We keep in touch; they come back; we have get-togethers and so on." He knows of six of his UROPers who are now in faculty positions at other universities, including Princeton. An equal number are in research posts; many work in industry.

Edmond suggests that UROP students wait until the end of their sophomore years or early in their junior

Continued on page A13

(L to R) Representative Peter Vellucci, UROPer Kenneth Sparks, '86, and legislative assistant Cliff Truesdell work on arson legislation to be introduced in this session.



UROPer Stephen Scaringe, '86, is a member of a team working on an implantable delivery system for insulin which would be sensitive to patients' glucose levels.

PHOTOS: FRANK REVI, '86, DONALD M. DAVIDOFF, '86

Seeing Infrared Stars Through the Rings of Saturn, Darkly

BY ANITA M. KILLIAN, '85

I never dreamed I would get my M.I.T. education outside of Cambridge or Boston, but there I was with seven other M.I.T. undergraduates on a plane bound for Arizona. We were going to spend three weeks last January participating in "hands on" astronomical research at the Lowell Observatory in Flagstaff.

My partner Ann Dalton, '85, and I were going to work on a UROP project designed to predict infrared star occultations (eclipses) by the planet Saturn for the next five to ten years. Our mentor was James L. Elliot, director of M.I.T.'s Wallace Observatory and assistant professor in the Department of Earth, Atmospheric and Planetary Sciences.

The project got off to a crawling start during the previous summer, when Ann and I were first assigned the task of making these predictions. Because no catalog or photographic sky survey of bright infrared stars exists, we had to devise a method based on existing data—a set of the Palomar Observatory Sky Survey (POSS) photographic prints. We used these prints to measure the diameters of the star images of those stars that Saturn would occult in 1984. With that information we could estimate each star's spectral type and predict its magnitude in the infrared region of the spectrum. To verify our predictions, we calculated actual values for these magnitudes from observations of each star. The entire process was mind-numbingly slow—it took Ann and me the entire summer to predict one year's worth of events.

When he noted our progress (or lack thereof), Elliot decided to send us to Lowell, which boasts a Photometric Data System (PDS) machine that can do what we were doing at the rate of one year per day—when it works, that is. Ann and I encountered every obstacle imaginable: bugs in the computer program that had never previously surfaced, a broken disk drive, mistakenly deleted computer files, etc.

At one point we almost had to abandon the project entirely. The POSS prints we were using were so dense that no light could pass through them on the PDS. Only photographs on plate glass or on clear plastic could be used. The observatory had a set of glass plates which would have been suitable, but, as our luck would have it, they covered regions in the sky directly above those we were interested in.

Ann Dalton (left) operates the Photometric Data System machine, which measures the magnitude of stars from their brightness on photographic prints, while Anita Killian mans the terminal collecting the data, on a UROP project which took them to the Lowell Observatory in Flagstaff, Ariz.

By chance, however, one Lowell astronomer had a collection of reduced positives of the POSS prints (the prints themselves are negatives). We took the positives of the pertinent regions and made negative sheet film exposures of these areas—enlarged to fit precisely within the range of motion of the PDS. For accuracy, we did a prototype run on the year 1985 and then checked it with the predictions for 1985 that we had made that past fall. The data matched!

We were back on the rails, but we had lost so much time that we had to keep the PDS working 20 hours a day to complete our measurements. I knew my shift was over when I woke to find I had been sound asleep at the terminal. By our last Friday there we had made predictions for events well into the year 1992. At that point we weren't thinking about science—only sleep.

Elliot will use our predictions to observe Saturn's ring's with the new space telescope that is due to begin operation in July 1986. Because the rings are very faint in the infrared region of the spectrum, they will stand out very clearly when observed during occultation of a very bright infrared star.

Astronomers are always concerned about making the best use of their access to a telescope. Being on earth greatly reduces astronomers' abililty to see distant objects clearly and with good resolution, so they are always seeking events that will given them a lot of good data at once. Occultations best suit this purpose because they involve only a point source of light (a star), and they are not obscured by general atmospheric turbulance. In fact, Elliot and Robert Millis of Lowell were using this technique to observe Uranus when they discovered rings around that planet in 1977—something no one has yet seen even with the most powerful telescopes.

If it proves possible to actually observe the first of our predicted infrared star occultations in September 1986, we will be the first group to ever observe such an event—not bad for an undergraduate research project.

ANITA KILLIAN *and colleague Ann Dalton are both completing degrees in physics this year. They are also continuing their project with James Elliot to gather astronomical information using occultations of infrared stars.*

PHOTO: JOE WAGNER, '86

UROPers contributed to some of the first work on acid rain.

Continued from page A11

years, when they have the necessary skills in analytical chemistry, before joining his team. He also asks that students plan to work for more than one term, because it takes a big part of that first term for students to acclimate themselves to the laboratory. But Edmond hastens to add that he thinks the "costs" to the professor in terms of training and supervision required for UROPers can be greatly exaggerated. He finds little difference between third- or fourth-year M.I.T. students and new graduate students from any other institution in the skills they bring to the job.

"What you get with UROP students is an enormous range of talent," Edmond continues. "I've had architects, chemical engineers, food scientists, chemists, physicists, and even a mathematician," a group almost impossible to assemble otherwise. He also finds that having undergraduates from many disciplines in his lab keeps him on top of events and issues elsewhere in the Institute.

(The communications function of UROP has also been noted by MacVicar. She says that some faculty members hang onto their jobs as UROP departmental co-ordinators for many years, at least in part because it is a great way to stay well-informed on the research activity within their own disciplines.)

Writing References Six Years Later

Being a UROP advisor involves Edmond in a lot of letter writing. Requests for job and graduate school recommendations for students who may have been away from M.I.T. for five or six years are not uncommon. "This kid was in my lab for two years, and this is what we did—in detail." That's the jist of his letters, and he is convinced that they carry much more weight than anything he could say about a student who had only been in his classes.

In all this discussion of the pros of UROP, there is a bottom line for Edmond: graduate students. Ultimately, he has to have master's and doctoral candidates and postdoctoral fellows to maintain the optimum research program. But traditionally trained chemists, naturally enough, tend to be steered toward graduate programs in traditional laboratories. UROP experience introduces them to less conventional fields—like water chemistry—in which to develop and utilize their skills. Seven students have received Sc.D. degrees under Edmonds' tutelage, and two doctoral students are working in his lab now. Of these, one-third came up through UROP, and many more of his UROPers are studying water chemistry and oceanography elsewhere.

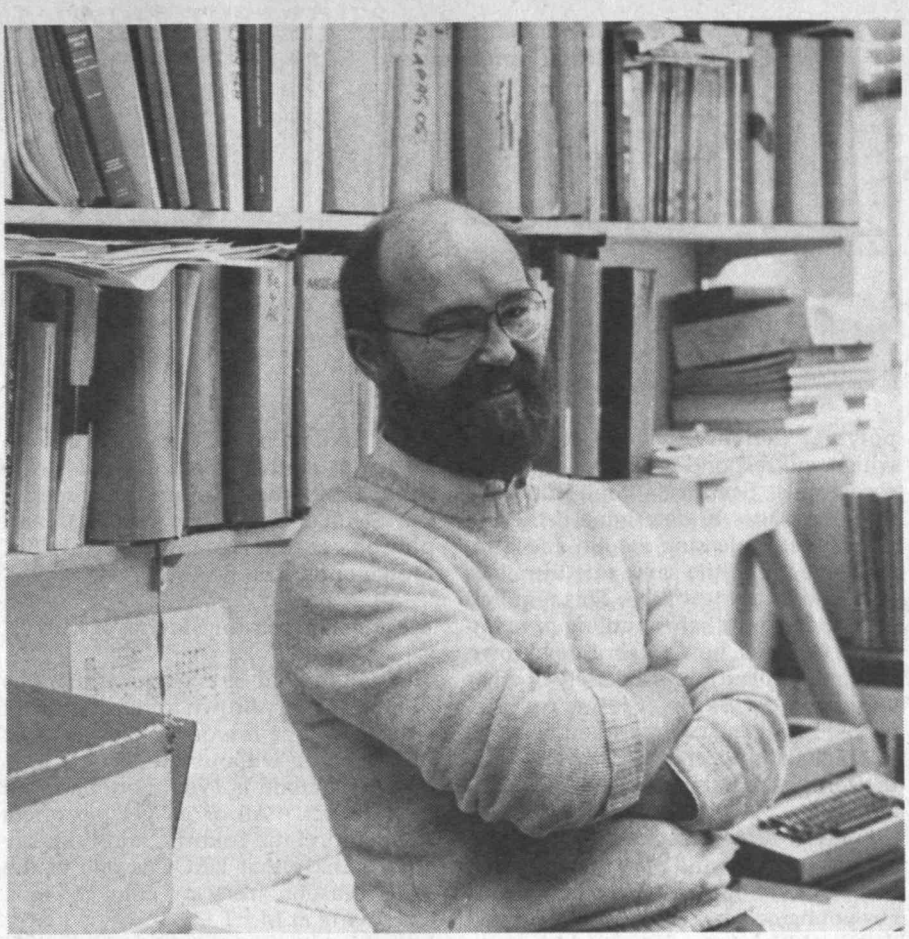
If faculty members like Edmond are impressed by what UROP students can do to advance their research, that can go double for graduate students. Some of the latter say that the work of UROPers lopped a year off the time it might otherwise have taken them to finish their degrees. Case in point is Larry Brown, Sc.D.'83, now a postdoctoral fellow in the research group headed by Robert Langer, Sc.D.'74, associate professor of nutrition and food science.

Langer's group, which includes 12 undergraduates at last count, has provided berths for more than 100 UROPers since his first appointment on the M.I.T. faculty in 1977. After interviewing potential UROP workers, Langer introduces them to the graduate students and postdoctoral fellows in the lab and encourages them to negotiate an agreement on a suitable UROP project.

When Larry Brown arrived from Brandeis in 1978 to begin graduate work with Langer, he quickly capitalized on this idea by enlisting UROP students as collaborators. Since then eight undergraduates have worked with him and many have had their names on published papers. One of those first students, Linda Siemer, '84, worked with him for three years, including summers, Brown reports, "growing with the project and anticipating the next steps."

Brown says he never would have finished his degree in 1983 without the undergraduate researchers, who carried out repetitive work requiring considerable technical skill, up to and including round-the-clock monitoring of experiments.

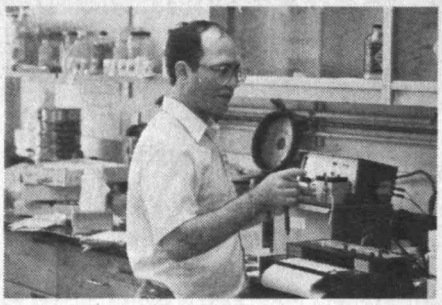
"There is something special about M.I.T. students," Brown says, citing the work of Stephen Scaringe, '86. Brown is now trying to develop an implantable



The publications of oceanographer John Edmond bear the names of many of his more than 100 UROP collaborators. He believes that freedom from bureaucratic constraints, which requires that the faculty have great confidence in the students, is what makes the program successful, perhaps unreproducable.

PHOTO: FRANK REVI, '86

Post-doc Larry Brown would not have received his Ph.D. in 1983 without UROP collaborators.



polymer delivery system for insulin which will respond to the patient's glucose levels. Scaringe's contribution to that effort was to determine if the implants were releasing insulin and a radioactive tag at the same rate in rats as they had in the test tube. This required that he learn the safe handling of radioactive isotopes, how to fabricate his own polymer implants, and a variety of other sophisticated skills, Brown reports. Since Scaringe usually worked between midnight and 6 a.m., Brown saw only the completed data, rarely his nocturnal assistant.

Finally, Brown decided that it was time to sit down and plan the next step, and left Scaringe a note to that effect. His young collaborator correctly figured that analysis of the data would have to come next, so he set out on his own to learn the mathematics required to do isotope counting. Scaringe then brought the results, completely analyzed and plotted, to the "planning" session. Brown admits he was stunned.

A Major Reason for Staying at M.I.T.

That is the kind of experience that has prompted Larry Brown to consider what a disadvantage it would be to teach at an institution without UROP.

John Edmond is even more blunt on that subject. "All of us get job offers from around the country, and I can say quite frankly that UROP is one of the major reasons, from my point of view, for staying at M.I.T."

And what of the students who are making these contributions to the career development and job satisfaction of their mentors? The documentation on that subject mounts in the UROP files with each term's crop of evaluation sheets, from which were lifted some illustrative comments from Lee Gehrke, assistant professor in the Harvard-M.I.T. Division of Health Sciences and Technology. He reports that research experiences, the *sine qua non* on an application for the HST Division of the Harvard Medical School, are very difficult to arrange for students who do not have the luxury of the UROP support network. And students with research experience "are more mature, more articulate, and much more knowledgeable and realistic about their career goals," Gehrke wrote.—*Susan Lewis*

PHOTO: FRANK REVI, '86

A. F. Friedlaender

Friedlaender Is Humanities Dean

Ann F. Friedlaender, Ph.D.'64, who only a year ago became head of the Department of Economics, is now dean of the School of Humanities and Social Science, succeeding Harold J. Hanham. She is the first woman to be an academic dean at the Institute.

Professor Friedlaender holds dual appointments as professor in the Departments of Economics and Civil Engineering, and she has written widely on the economics of transportation. She entered M.I.T. for graduate study from Radcliffe (B.A. 1960), and between 1965 and 1974, when she joined the M.I.T. faculty, Professor Friedlaender rose to the rank of professor at Boston College. She was a Fulbright Lecturer in Helsinki, Finland.

Friedlaender's job, following in Dean Hanham's footsteps, will not be easy. As Francis E. Low noted in announcing her appointment, four departments in the School of Humanities and Social Sciences—economics, linguistics, philosophy, and political science—are "ranked among the best in the country, due in large measure" to Hanham's leadership.

After 11 years as dean, Hanham is on leave of absence this year and will become vice-chancellor of the University of Lancaster in October 1985. □

New Alumni Jobs For Johnson, Alexander

Two major new assignments in the Alumni Association are now in effect:

□ Paul E. Johnson, formerly regional director for the Gulf/Atlantic states, has been named national director of the M.I.T. Enterprise Forum, a new post.

□ Louis E. Alexander, formerly assistant to the regional director in the M.I.T. Alumni Center of New York, has moved to Cambridge to assume Mr. Johnson's former duties.

The Enterprise Forum, an outgrowth of volunteer alumni activity in New York and Boston, now has operating units in Cambridge, New York, Washington/Baltimore, Chicago, Miami, Houston, Los Angeles, Seattle, and Stamford (Conn.). Mr. Johnson's duties will be to coordinate and assist in the development of these growing activities—all of which have the purpose of providing voluntary assistance to new ventures and inventors who seek to commercialize their discoveries.

Johnson has been with the Alumni Association as a regional director since 1979, the same year in which Alexander joined the New York office.

P. E. Johnson

L. E. Alexander

Who is this diver? This photograph, taken with a multiple-strobe-flash technique, has turned up unidentified in Professor Harold E. Edgerton's archive. "Doc" believes it was made in the mid-1960s—and will be grateful to any* Review *reader who can name the athlete.

Journalists Honored

Vannevar Bush Fellowships for one year of study at M.I.T. in 1984-85 have been awarded to eight writers specializing in science and technology. They are spending their current academic year at M.I.T. on programs of their own choosing under the direction of Victor K. McElheny, fellowships director, in the Program in Science, Technology, and Society. The eight:

□ Lew Frederick, KGW-TV, Portland, Ore.

□ Paul A. Haskins, *The Sentinel*, Wiston-Salem, N.C.

□ Richard M. Hope, McGraw-Hill World News Bureau, Washington, D.C.

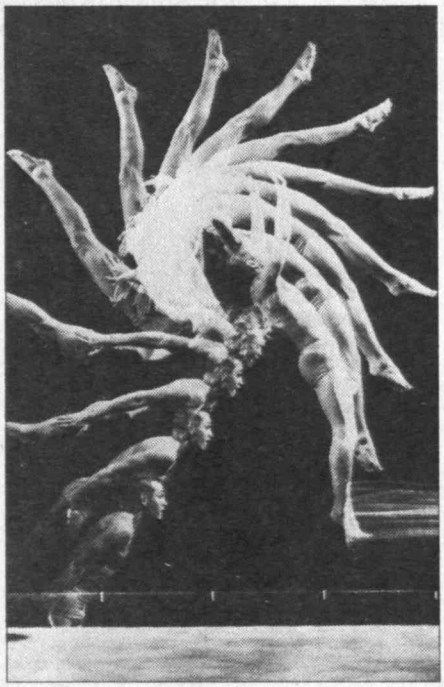
□ Jeanne A. McDermott, freelance writer, Cambridge, Mass.

□ Kristine D. Moe, Journal-American, Bellevue, Wash.

□ Charles W. Petit, *Chronicle*, San Francisco, Calif.

□ Ellen Ruppel-Shell, freelance writer (formerly senior editor of *Technology Review*), Jamaica Plain, Mass.

□ Laura A. Simmons, *Times Daily*, Florence, Ala. □



Anatomy of a Donor

Why I Gave $40K To M.I.T. Project Athena

Why do donors put their money where they do? Some have fuzzy answers. Not so Robert M. Metcalfe, '68. Only 20 years after he entered M.I.T. as a freshman, Metcalfe donated shares in his company, 3Com, with a market value of $40,000 to support Project Athena.

Metcalfe holds bachelor's degrees from M.I.T. in electrical engineering and management and graduate degrees in applied mathematics and computer science from Harvard. His commitment to the Institute was reinforced by experience on the research staff of Project Mac with Professor Joseph Licklider and for Professor Michael Dertouzos at the Laboratory for Computer Science. In 1979 he founded 3Com, which four years later had grown to have revenues of $16 million.

Having built his successful business on computer networking technology, Metcalfe could be expected to be particularly supportive of Athena, a project for networking computers in education and research. But his inspiration to give is complex; it reflects more than just the importance of the project at hand, as Metcalfe revealed in a recent letter (*right*) to Eric C. Johnson, '67, assistant dean of engineering.

To Eric C. Johnson, '67, from Robert M. Metcalfe, '68:

I have been giving money to M.I.T., on and off, since graduating—$50 here, $100 there, and $500 in a good year. This year I found myself able to give $40K and I found myself enthusiastic about it. Why? The simple reason is gratitude. The more complicated reason is my belief that if you take something out, you have to put something back in. M.I.T. is an institution that worked for me.

M.I.T. did indeed work for me. I arrived in the fall of 1964 with a $300 scholarship and my parents' life savings. By June I had learned a trade (6.251) and was economically self-sufficient. Because I began working full time as a computer programmer the fall of my sophomore year, I attended (but slept through) many of my classes in the next four years, relying heavily on allnighters. I was awake enough to find beauty (6.05) and that I could put up with almost anything (5.02).

What did I learn? Professor Corbato taught me that computers can do more than one thing at a time, while Professor Licklider taught me that, among the things that computers do, communication is the most important. Professor Gray taught me the essential analog details of transistors (6.02), and then Professor Troxel taught me they could safely and productively be ignored by those of us choosing to live digital (6.711). Professor Drake taught me to apply uncertainty (6.28), and Professor Schein, agreeing, taught me to consider the human side of enterprise. Coach Crocker taught me how to win, even after losing the first set.

Professor Minsky taught me that it is not enough to be profound—you must be articulate, and then Professor Dertouzous taught me that it is not enough to be articulate, you must be right (6.001). It was Professor Forrester who taught me the merits of perfectionism and—get this—how to put words on paper.

Why did I give $40K to M.I.T.? To say thanks, for sure, and to support the important work ahead. As my good fortune continues, I hope to give more. I have in mind the Metcalfe Memorial Racket Sports and Computer Networking Center, overlooking Brookline, Cambridge, and Boston with a view of Cape Cod. It would have to be painted green. I want, at last, to provide a home for those who wander M.I.T.'s campus looking for the green building.

New Members of Your National Selection Committee

Elected to 3-year terms on the NSC are (clockwise from top left) Virginia Grammer, '47; Kenneth Gordon, '60; Paul Fricke, '61; and Donald Robison, '46.

11

On August 18, 1984, I spoke by telephone with two 1911 classmates: **Stanley H. Lawton** and **Edward Sisson**. Stanley Lawton, age 94, resides in Cambridge, Mass. His closest relatives are cousins in California. His hobby was gardening—flowers and shubbery—but he gave that up three years ago. He says he is in pretty good health, with three nurses to take care of his needs. . . . **Edward Sisson** lives in Chestnut Hill, Mass. His family consists of three children and nine grandchildren. He has been active during his career in ownership and operation of a structural steel business. He is retired, and the business is being carried on by his son and a son-in-law, the latter an M.I.T. graduate. Edward's voice sounded clear and alert.

I am disappointed that I have not been able to learn more about the 1911 class. I will keep trying. Please send news about yourselves.—**Gardner C. George,** Secretary, 3960 N.W. 11 St., Coconut Creek, FL 33066

14

Lester T. Forbes died on June 16, 1984, at the age of 92, in a nursing home near his residence in Merrimack, N.H., where he had lived for seven years. He was born in Framingham, was a member of our class in all our undergraduate years, received his S.B. degree with us in Course VI, and served as an ensign in World War I. He was with the Submarine Signal Corp. beginning in 1917, first in Boston, then for 13 years in France, in Boston again, and in 1948 was New York district manager for that corporation. Later he was an electrical engineer with Raytheon Co. For 35 years his home was in New Rochelle, N.Y. Lester is survived by a daughter, Mrs. Nancy Myers, of North Abington, Mass.; a son, Malcolm Forbes, of Merrimack; and seven grandchildren.

Israel H. Lovett died on April 8, 1984, at the age of 94. He was born in Council Bluffs, Ia., was a member of our class in our last three undergraduate years, and received his S.B. degree with us in Course VI. After working as an electrical engineer with power companies in Chicago, Omaha, and Worcester, he joined the faculty of what was then the School of Mines and Metallurgy of the University of Missouri, in Rolla, in 1921, was on the faculty of that university until his retirement in 1960, and was chairman of the electrical engineering department from 1948 on. He received the professional degree of electrical engineer from the university in 1924 and an M.S. in engineering from the University of Michigan in 1928. Professor Lovett was a fellow of the Institute of Electrical and Electronics Engineers, a member of the American Society of Engineering Education, of the National and Missouri Societies of Professional Engineers, and of the Eta Kappa Nu and Tau Beta Pi honorary societies. His passing brought forth many tributes from his associates and former students, who spoke of him as "a man who endeared himself to every person who neared his path." Another comment: "He was one of the kindest, gentlest, and most generous men I've ever known." He is survived by a daughter, Harriet B. Lovett, and two grandsons, all of Cleveland. His wife, the former Elizabeth Maryette Beach, whom he married in 1916, died in December 1983.—**Charles H. Chatfield,** Secretary, 177 Steele Rd., West Hartford, CT 06119

15 70th Reunion

Frank J. Hull is fine and sends regards to his classmates. His current address is 1332 N. Market St., Jefferson, OH 44047. . . . At this writing **Herman Morse** is very ill and needs the prayers of each of us for himself, his wife Marjorie, and his family. . . . I had a delightful note from Amy Ford Stearns, whose husband, **Edmund R. Stearns,** was a '15er. She still keeps "oh, so busy." She went to Europe again for the fourth time, with a group conducted by her minister and his wife. If there is a 70th reunion for '15ers, Amy says she would try to attend. . . . Went to Fairlee, Vt. for the National N.E. Congress. **Mimi Rice** was not present this year, but Mimi did attend the patriotic meetings in Washington.

I have been involved with the 50th and 60th reunions, but as you classmates know, **Azel Mack** headed them. I simply attended, and at the 60th was a hostess. I will be writing each of you soon to see how many would be able to attend a 70th reunion. It is food for thought.

Mimi Rice says she is truly amused by our class notes and **Loring Hall**'s diary. She has even xeroxed some of the notes for her four children. She remembers the incident of the fellas kidding Loring because he had to sit next to her, a coed. She doesn't know why "Hall" was next to "Plummer," since the lecture theater was huge. When Professor Cross's assistant asked her one day how M.I.T. was treating her, a co-ed, Mimi replied "Very unfairly, we gals are greatly discriminated against." Mimi thanks Loring and said she loved every word of his diary! Loring asked me to pass along to Mimi (whom he called "Mary Elsa") that he knows she is a good sport and wouldn't resent his intimation that he sat next to her only because he had to.

Loring wrote me on his 91st birthday and sent some more diary notes from January 1 to May 27, 1913. He says, "After all, an M.I.T. education includes a lot of little episodes that help to lighten the load of studying and taking exams." While reading over his notes, he noticed the second year was much tougher than the first, and that there was less time for athletic activities. Many a night he studied way past midnight. More diary:

January 2, 1913: Became M.I.T. agent for the Aluminum Cooking Utensil Co. Signed up Stuart Gurney to work for me next summer. As his deposit he gave me a five-dollar goldpiece. Alex Keltic will also be in the crew.

January 3, 1913: Had math conference with Professor Passano. Among other things, he told me that he considers two characteristics essential to a successful career, imagination and a sense of humor. Good advice!

January 7, 1913: Got an "L" on the last European history exam. Professor Currier said 270 failed out of 300.

January 15, 1913: Became a member of the Civil Engineering Society. Bought a 3-foot steel straightedge for $2.40.

January 28, 1913: Had my first lesson in driving. Ray Greene let me drive his Winton. Got up to 25 mph at times. Very exciting!

March 3, 1913: Professor Charlie Cross presented a lecture on radioactivity, in which he showed some beautiful spark discharges through different degrees of vacuum.

March 18, 1913: After surveying, Professor Howard gave us an illustrated talk about his experiences while settling a boundary dispute between Costa Rica and Panama.

March 21, 1913: Had our first class in topographical drawing with Dean Alfred Burton as our instructor. He is a fine man.

April 5, 1913: Went to President Maclaurin's house at 187 Bay St. Entertained about 35 Tech men. We played a guessing game, then listened to some music, and finally had some excellent refreshments. Charlie Shaw, Dutch Baus, and John Gallager were there.

April 8, 1913: The telephone company has imported 600 girls from New York to break the pending operators' strike. They are all staying at the Copley Plaza. Nelson Stone and I went up on the roof of Engineering Building A and had fun with a couple of cute girls from Brooklyn.

May 8, 1913: The Civil Engineering Society had its annual banquet at the City Club. There were excellent speeches by Professor Spoford, Professor Swain, Mr. Munroe, and Mr. Rollins. I was elected assistant treasurer.

Loring mentions that the next notes will be on the interesting weeks spent at M.I.T. civil engineering camp at Garden Lake, Maine.—**Joyce E. Brado,** Acting Secretary, 491 Davison Rd., Lockport, NY 14094

16

As this is being written, we are planning a class luncheon for mid-August in the Greater Boston area. Many, many good men and women shared in the greatness of the class, and as long as we can we will come together annually to celebrate our good tidings and honor the memory of our classmates who have departed.

John Fairfield writes, "The 4th of July: that always brings back memories—what fun it was to wake the old folks at dawn with firecrackers, and burn one's fingers as long as the fireworks lasted, and be sheparded off to wash up and to bed. What a day! Reading the alumni notes brings back other pleasant thoughts—the fine reunions and seeing again the friends of the '16 class. **Paul Duff**'s plea for a reunion at his place is typical generosity; thoughts of a genial host are kindled. (But also of 150 miles distance, and 90-year old reflexes and strength). But thanks ever so many, Paul.

"I'm OK: emphysema, angina, endema under control; no serious troubles, so I garden (spade,

hoe, weed, prune, etc.) judiciously (more than timidly); live alone (but have a dog, which I never had when I was young; had one for my children, and now get tremendous solace from this specimen). Good friends for neighbors, attention from loving children. 'Let not the sun go down upon thy wrath' is a wonderful motto to try to live up to. So, keep on breathing!"

Dina Coleman writes: "I appreciate your letter of July 2. I think it is very kind of Paul and Frances to offer their house, and I am sorry that I will not be there. I have no words of wisdom that might interest the class at this time." . . . From **Elbridge Devine**: "At our 65th reunion we made a future date. This would be a good time to keep that date, but I just can't make it now. My thoughts will be with you." . . . From **Charlie McCarthy**: "Your letter of July 2 reminded me that I have not written to let you know that Betty passed away on September 23, 1983 after a long illness. I still miss her very much. I am pleased to learn that you are planning a class reunion. I regret I must pass up this opportunity to have a visit with you and the other members of the class of 1916 who are able to attend. I visited my physician a few days ago and he gave me the comforting news that my general health is in fine condition. However, I do have a long-standing problem with my back which causes me to tire quite easily. Consequently, I find it prudent to limit my driving distance to about 60 miles. Please give my regards to all the '16ers who come to the luncheon."

From Frances (Mrs. **Paul) Duff**: "Paul is great, taking walks all the time, only sometimes forgets to come back. Everyone knows him, so they either drive him home or call me. He's wonderful." . . . From **George Crowell**: "Am still enjoying good health except for my eyesight. Go to the office every day and attend bank meetings regularly. Best regards to all and especially to the Paul Duffs for their kind offer." . . . From **Henry Shepard**: "Frances and I feel that a reunion at the Colonial Inn is preferable to going as far as Peabody. It was very nice of Paul and Frances, but Wakefield is a shorter distance for us to drive."

Also heard from **Don Webster**: "The plans for a reunion at the Duffs' sound very appealing, but our perimeter is presently limited to our own backyard. Please give our greetings to all '16ers." . . . **Joel Connolly** writes: "I regret that the stroke I had makes it hard for me to take long trips, so I will have to be excused from the Class of 1916 reunion. My wife, Virginia, died on May 4, 1984. Please drop in when you get to Tucson." . . . Talked with **Dan Comiskey,** and he reported that June had been tough for them. Grace fell and scraped her back and was hospitalized for a couple of weeks; he was in the hospital for a week with a sugar problem; and they had an oil spill in their cellar. . . . In a conversation with the **Izzy Richmonds**, we were pleased to hear that Izzy is doing very well, that they had spent the winter in Spain, and that Anne plays golf six days a week. . . . **Doug Robertson** told us that he had recently been swimming at the beach in Falmouth.

I talked with **Barney Gordon,** and he indicated that he was looking forward to joining us for the reunion luncheon. Then came the day of the reunion luncheon. I picked up **George Ousler** in Andover and together we went to Chestnut Hill to get **Barney Gordon**. Unfortunately, Barney was entertaining unexpected guests from Israel and could not leave to attend the reunion. He looked great. Our disappointment was probably exceeded substantially by his own for not being able to attend. George and I were joined at The Pillar House on August 15 by Frances and **Paul Duff** who were accompanied by their son, John, and his wife, Estermarie; Frances and **Henry Shepard,** Anne and **Izzy Richmond; George Crowell,** who was accompanied by his son, Bruce; **Dan Cominskey;** and Sibyl (Mrs. **Ralph) Fletcher,** who gave corsages to the ladies and red carnations to the men. Paul Duff and I wore the red jackets which were first worn 18 years ago at our 50th reunion. In the quiet of a private-room setting, we paused in prayer to ask God's blessings for all the wonderful men and women, living and dead, who gave so much of themselves through the Class of 1916 for the joy and encouragement of all '16ers. It was a marvelous luncheon, with some very remarkable people, celebrating a truly rare occasion, our 68th reunion. Our sights now are set on our 69th next spring, when hopefully others will join us.

We offer our sincere sympathy to **Charlie McCarthy** and to **Joel Connolly**. . . . Keep the letters coming, so that our column will continue. Keep eating, drinking, walking, breathing—everything in moderation; and, of course, write to us.
—**Bob O'Brien,** Acting Secretary, H.E. Fletcher Co., Groton Rd., W. Chelmsford, MA 01863 (617) 251-4031

17

On May 25, **Brick (Atwood P.) Dunham**'s family held a special reunion to celebrate his 90th birthday. Then in June his wife, Edna died of pneumonia. Brick, we send you our sincere sympathy.

Dr. Roger Payne, son of our 1917 classmate **Edward Payne,** is known as "one of the world's leading authorities on whales." On August 9, at the Bar Harbor Club in Bar Harbor, Maine, I had the pleasure of hearing him give an illustrated talk on whale behavior and ecology that was sponsored by the World Wildlife Fund, U.S. and the College of the Atlantic.—**Walter J. Beadle,** Secretary, Kendal at Longwood, Box 217, Kennett Square, PA 19348

18

It was with great joy that I read a letter to the editor of the *Wall Street Journal* by our own **Bill Foster,** a fomer deputy secretary of defense and the first director of the U.S. Arms Control and Disarmament Agency. It was in reply to an article in that paper on July 10, 1984 by Zbigniew Brzezinski. Foster asserts: "Weapons modernization is a function both of technological innovation *and* political decision making." He says, "We must look to political negotiations, not inventions of science, as our best hope for reducing the risk of armed conflict." Foster points to the 1972 Anti-Ballistic Missile (ABM) Treaty, banning nationwide systems to defend against ballistic missile attack, as an example where both sides endorsed the view that mutual vulnerability requires mutual restraint and that the move to develop defensive systems undermines deterrence. He concludes that the ABM Treaty proves that arms control can be a necessary brake on technology if applied seriously and creatively.

We are the proud owners of a new book, *The Prints of Samuel Chamberlain N.A., Drypoints, Etchings, Lithographs* by Narcissa Gellatly Chamberlain and Jane Field Kingsland. It is a most complete work, with reproductions of nearly 300 of Sam's prints, all of these most interesting to study. In addition, many of his associates make their assessment of Sam, making this volume all the more revealing of Sam's achievements. I recommend your reading this book. Get it from your library if you do not purchase it.

I regret to report the death of **Sherman MacGregor** in February 1984. During World War I, he served as a second lieutenant in the U.S. Army Corps of Engineers, and after his military service attended Harvard University School of Engineering. He worked as an engineer for 15 years and was in charge of construction of the disposal plant at Rockefeller Center. He had always been interested in radio and in 1934 became production manager of pioneer radio station KDKA in Pittsburgh. In 1936, he joined the NBC production staff in New York and was writer and director and was put in charge of casting of such radio programs as "Nick Carter" and "Renfrew of the Mounties." MacGregor then moved to station WOR in New York, where he produced a number of series of programs. He also pursued his career in Broadway plays, playing secretary of war in "Yours, A. Lincoln" with Vincent Price. On television, he had a few small roles in TV shows like "I Remember Mama" and in 1962 he did a TV movie for Walt Disney, "The Wahoo Bobcat." MacGregor is survived by a daughter, Joan Cheney of Fall River; a sister, Edith M. Thomas of Brockton; four grandchildren, John, Lynne, David, and Brian Cheney, and three great-grandchildren, three nephews and four nieces.

Through the M.I.T. Alumni Office I am advised of the deaths of Mrs. **Wirt Robinson** and **Roberto Garza Sada**.—**Max Seltzer,** Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard Levine,** Assistant Secretary, 519 Washington St., Apt. 15, Brookline, MA 02146

19

From time to time when we learn of the death of a classmate, we use these notes to pass on to you any information we have about the highlights of his or her career. We are invariably impressed with the common thread as it were of these summaries—success in their chosen careers, service to their country and humanity, and devotion to family.

Sometimes we obtain similar information on living classmates such as **Lester Wolfe** and **Robert B. MacMullin** in his book *Odyssey of a Chemical Engineer*, both of which were passed on to you in recent issues of the *Review*. Now we have a communication from our distinguished classmate **Timothy E. Shea**. He writes: "In view of the uncertainties of age, I list for you the principal honors I have received: Presidential Medal of Merit, 1946; Distinguished Civilian Service Medal, 1968; honorary doctor of engineering from the Case Institute of Technology, 1950; Papal Knighthood, for charitable work done in New Mexico, 1955; member of the National Academy of Engineering, 1967; Western Electric Engineering Research Center, which I founded in 1958, dedicated to me, 1983. A Pacific Submarine Official wrote me, 'Many young Americans returned safely home, who would not have done so, but for your work. No doubt many thousands of other lives were saved by our anti-submarine work in the Atlantic.' "

The '19ers who attended the 65th reunion (see photo, *Technology Review*, October 1984) are the men who voted favorably for a 70th year reunion.—**W.O. Langille,** Secretary, P.O. Box 144, Gladstonne, NJ 07934

20 65th Reunion

A warm letter from **Frank Marconi** of Leominster says that he is active in local affairs and that he and Kay are off on a trip to Nova Scotia going as far as Ingonish where your secretary used to hang out at K Lodge. Frank and Kay are in for a treat as that is one of the beauty spots of the North Atlantic.

Roger Haven, '28, of Fryeberg, Maine has been thoughtful enough to send me a leather-bound Class Day booklet of the Class of 1920. He came across this booklet in going over a deceased relative's belongings, and it occurred to him that it might be valued by the class secretary. That supposition is eminently correct, for I had great interest and satisfaction in examining this relic of our noble class. The roster of the Class Day committee includes so many prominent and beloved classmates that I am impelled to list them: **John Abrams, Norrie Abbott, Ken Akers, Art Atwater, Ralph Booth, Larry Boyden, Skeets Brown, Perk Bugbee, Francis Bunker, Buzz Burroughs, Count Capps, Bart Casey, H.O. Davidson, Harmon Deal, Dick Gee, Jimmy Harrop, Mouse Meissner, Jimmy Moir, Johnny Nash, Bob Patterson, Ray Ridgeway, Ken Roman, Harold Smiddy, Creighton Stanwood, Lee Thomas, Frank Travers,** and **Murray Whitaker**.

As I write each name I am able to picture them perfectly. What a swell gang they were! The Class Day events included a baccalaureate sermon at the Old South Church, a picnic at Nantasket, a senior dinner at the old Boston City Club, a dance at Walker Memorial and a Pops concert at Symphony Hall. A complete listing of the class stood at 331. Names that stand out in my mind (of course I can't cover them all) are the following: **Bink Carleton, Larry Allen, Herb Bates, Karl Bean, Harry Blount, Fritz Boley, Fred Bowditch, Frank Bradley, Freddie Britton, Dorothea Brownell Ridgway, Al Burke, Phil Byrne, Hank Caldwell, Warren Chaffin, Ki Chun, Buck Clark, Archie Cochrane, Bud Cofren, Hank Couch, Jack Coyle, George des Marais, Bill Dewey, Foster Doane, Herb Dorr, Snug Elter, Ed Farrow, Herb Federhen, Dave Fiske, Flossie Fogler, Leland Gilliatt, Al Glassett, Dolly Groy, Phil Haebler, Heinie Haskell, Harold Hedberg, Bill Hedlund, Dan Hennessy, Henry Hills, Homer Howes, Ernie Huntress, Tex Imhoff, Harry Kahn, Don Kimball, Archie Kinghorn, Charlie Klinger, Merritt Knox, Pete Lavedan, Frank Lawton, Carl Leander, Mal Lees, Morris Lipp, Jack Logan, Dan Lord, Ed McCarthy, Henry Massey, Art Merriman, Dusty Miller, George Morgan, Ken Newhall, Tom Orchard, Art Radasch, Stan Reynolds, Robbie Rubillard, Sam Ruttenberg, Jim Scott, Monroe Shakespeare, Bob Sumwalt, Jerry Tattersfield, Bat Thresher, Bob Tobin, Ned Van Deusen, Scott Wells, Larry Weymouth, K.B. White, Ernie Whitehead, George Wilson, L.D. Wilson, Jim Wolfson,** and **Phil Young**.

Forgive me if I have omitted your favorites. Perhaps these individuals were faithful attendants at class reunions, perhaps outstanding in other fields. At any rate it gives me nostalgic and fond recollections of a colorful and characterful class. I commend them to your own recollection. Incidentally, George Haven who sent me the booklet says that **Harold Blount** was a stepcousin of his.

An uplifting letter from **Lee Thomas** details Florence and Lee's visit last June with Denise and **K.B. White** at their chateau. Lee says that "K.B.'s sense of humor is sharp as ever and Denise is charming as ever. Anyone who has visited the White's 13th century Chateau d'Arthies will never forget it, with all the priceless antiques and other treasures, the beautiful grounds, and the quaint French village," says Lee. Florence and Lee spent a month in Europe visiting England, Scotland, France, Switzerland, and returning from Germany. They spend their winters in Naples, Fla.

I regret to report that one of this distinguished number, **Foster Doane,** died on July 16 after a long illness. His wife, Gladys, writes that he had great respect and love for M.I.T. Foster was a resident of Neenah, Wisc. (50 E. Wisconsin Ave.) for more than 30 years. He was a vice-president of manufacturing at Bergstrom Paper Co. Besides his wife, he leaves two sons and three grandchildren. He was an outstanding credit to his class.—**Harold Bugbee,** Secretary, 3 Rehabilitation Way, No. 702, Woburn, MA 01801

21

This is the month when I have no news other than two obits received by the Alumni Office. I've been expecting this to come for the past year as news has gotten scarcer and scarcer. I see other classes near 1921 with columns omitted, but I hate to break **Cac Clarke**'s long record of never missing an issue. It's up to you. I'm not writing fiction.

I just looked at my list of "living" classmates and found lots of familiar names I haven't heard about for years. Does anyone have any news of **Francis Blewer** and his former partner in the brokerage business, **Dick Windisch**? I'm also wondering about **Robert W. Barker, Harry Butters,** and **Carl M. Cohen**. In St. Petersburg, there are **Glen Fargo** and **Don Lyman**, whom I haven't heard from in years. Out on the West Coast, there is **Harold Cake** and **Ed Chilcott, Gus Kinzel** and **Williston Wirt**. And I'd like to hear from **Arnold Davis, Ben Fisher, Eddie Haywood** and **Jim Parsons**.

It is my sad duty to report the deaths of two classmates: **Francis T. Hill** of Cambridge, Mass. on October 13, 1983 and **Harold A. Tucker** of Belmont, Mass. on June 28, 1983.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 12203; **Josiah D. Crosby,** Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden,** Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

22

During an August vacation trip to Michigan our class president, **Parke Appel,** and his wife, Madeline, had a brief enjoyable visit with **Ab Johnson** at Ab's summer home in Crystal Downs. Parke reports Ab to be in fine shape after his hip operation early this year. . . . The August, 1984 issue of the *IEEE Spectrum* published a letter from **Bill Elmer** in which Bill challenges the world's robot experts to duplicate electronically the performance of his little 37-pound dog in catching morsels of raisin buns tossed to him occasionally. Quoting from Bill's letter: "His performance is spectacular. He is able to calculate the parabolic trajectory of the morsel, regardless of its height or direction, and catch it in his mouth often in the split second before it has reached its apogee. He can do this at all levels from a crouch to catch low-flying morsels to a jump to catch high ones. His accuracy is astounding, showing that his internal computer can calculate a parabolic course and give complete and elaborate instructions to his nervous system, including the opening and closing of his mouth at the right microsecond. . . . Until electronic technology can equal the computer in the brain of a little dog, its very honor is at stake."

Speaking from personal experience, your secretary sincerely hopes none of you suffers an attack of polymyalgia rheumatica (translation—very painful muscles). Cause unknown. It renders one a temporary muscular cripple, no strength in knees and arms and with extraordinary pain accompanying the slightest movement. Recovery slow, aided by cortisone medication. Now after three months, about 75 percent back to normal. Still can't swing a golf club.

One death to report. **Earl E. Mader,** Course I, retired, died September 12, 1983 in Thomasville, Ga. The 1967 Alumni Register shows him to have been the regional director of the U.S. Office of Emergency Planning for Region 3. I have no information as to his survivors. A curious coincidence: Both **Bill Dickerman** who died last March and Mader prepared at Taunton (Mass.) High School and both entered M.I.T. when they were only 16 years old. Taunton High must have been a pretty good school in those days and Dickerman and Mader exceptionally bright young men.

My actuarial friend tells me that the life expectancy of those born in 1900 is about 4.6 years so send in your comments while there is still time.—**Yardley Chittick,** Secretary, Box 390, Ossippee, NH 03864

23

Katie and **Herb Hayden** celebrated their 60th wedding anniversary on June 16. They were married in Lewisburg, Pa. Katie's father was head of the chemistry department at Bucknell University, and Katie was the first woman graduate there with an engineering degree (chemical), in 1923. **Clark Barrett, Forrest "Frosty" Harmon** and **Howard Dexter** were members of the wedding party. The Hayden family now has grown to three children, 11 grandchildren and 11 great-grandchildren. Most of the family was on hand for the open house on June 16. They came from Alabama, Tennessee, Maryland, New Jersey, and Greece. About 135 friends were present, including Phil Freeman, '41, and Russell Amback, '24. Congratulations to the Haydens!

Royal Sterling has appointed **Jerry Fitzgerald** to be chairman of our 60th reunion committee. Plans are under way. Send him any ideas you may have to: 128 River Dr., Hadley, MA 01035.

Francis Kurriss died on July 25, 1983. He graduated with our class in mechanical engineering. He was associated with Bell Telephone Systems from 1923 to 1960, serving in various engineering and supervisory capacities with Western Electric Co. and New York Telephone Co. Most of his career was spent with the latter company, where he served as engineer of buildings and equipment and later as engineer for plant extension for the Manhattan-Bronx-Westchester area. In 1955 he was appointed manager for the newly established Westchester area and headed a new type of telephone engineering—commercial, traffic, plant, and general engineering. He held the post until his retirement in 1960. In 1958-59 he was president of the Empire Chapter of Telephone Pioneers of America. Following his retirement, he did some communications consulting work. He was active in veteran affairs, having served in World War I as a first lieutenant in the Yankee Division. He entered the service as an enlisted man and was commissioned in the field for gallantry in action.—**Richard Frazier,** Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

24

With the memory and enthusiasm of our 60th Reunion urging them on, your newly elected class officers gathered to discuss plans for the 65th at a luncheon in the beautiful rotating Spinnaker Room atop the Hyatt Regency Hotel. The chief subject talked over was how to encourage more personal contact between classmates, obviously missing. Distance seems to be the obstacle and the solution appears to be a number of widely-spaced "regional mini-reunions." Let's have your suggestions.

Your secretary has been overwhelmed with death notices. A very nice letter from Benedicte, wife of **Kaare Aass,** tells of his death from heart disease May 9, 1984 in Oslo, Norway. She mentioned how greatly they appreciated the generosity of **Ed Moll** in 1940, when he offered his home in the States as a refuge from the German occupation of Norway. Kaare earned his S.B. in Course XI, sanitary engineering. He further became a Master Plumber (four years required for license) and took over his father's business of heating and sanitary contracting. At the Institute, he was president of the Norwegian Students Club.

Clare Harvey, wife of **Gordon Harvey,** sends a note advising of his death on July 7, 1984 in Boynton Beach, Fla. He had not been well for some years, but he suffered a broken hip that gradually weakened him in five weeks. Gordon was awarded his S.B. in civil engineering. He spent his career with the New York State engineering organization and at one time became chief engineer. He was involved in the New York World's Fair, Montauk beach development, highway engineering, state parks, parkways and various construction. Finally, he was chief engineer and regional park manager Genesee State Park Commission.

A note on an Alumni Register Questionnaire, signed by his wife, records that **C. Julian Oberwarth** died April 23, 1983 in Eutaw, Ala. He gained his S.B. in architecture, having prepared at the University of Kentucky. Oby was a member of the Frieze and Cornice, the Honorary Architectural Society, Institute Finance Committee, Tech Show and Choral Society. He spent his entire career in architecture in Frankfort, Ky., except for U.S. Navy service in W.W.I. For 14 years, he was secretary and treasurer of the Kentucky State Board of Architects; director of the American Institute of Architects and active in a number of community organizations and contributing to

books and journals.

Henry B. Robison died September 6, 1983 in Raleigh, N.C. He registered with us in his junior year for general engineering after preparing at North Carolina State College. He joined the Carolina Light and Power Company in Raleigh, advancing to executive vice-president and operating manager.

Word has reached us belatedly via the Alumni Register Questionnaire that **Seymour F. Stewart** passed away July 28, 1980 in Wichlitte, Ohio. Little is know of his career, except that he became vice-president and general manager of EMD Components, Inc., Aurora, Ohio.—Co-Secretaries: **Russ Ambach,** 216 St. Paul St., Brookline, MA 02146; **Dick Shea** (11/1 to 5/1, 709 Cypress Pl., Sun City Center, FL 33570) and (5/1 to 11/1, 7 Barkley St., South Yarmouth, MA 02664)

25 60th Reunion

A preliminary notice regarding the 60th reunion has reached you by now, and hopefully you have responded. If you have put off answering, an early reply will be much appreciated by the committee. **Virgil (Hal) Halliburton** writes from Nevada, Mo. making some suggestions as to reunion plans, and his thoughts have been passed on to president **Jim Howard**. Hal and Katherine are looking forward to the reunion.

A letter from **Henry Sachs** brings us up to date on his activities. He is living in the New York apartment which he bought in 1952. It is a cooperative. He is still active in the insurance brokerage business but no longer in the administration, so his time is his own. He and Bea do quite a bit of traveling and seem hooked to the Royal Viking Line. Last winter they took a segment of a trip around South America—San Juan, Cartagena, San Blas Islands, Panama Canal, Lima, Peru, and some small ports in Chile and Argentina. They cruised in the Straits of Megellan, thence to Buenos Aires and Rio, then home. Last June they took the Royal Viking from Southampton, England to the North Cape and on the longest day of the year saw the sun for 24 hours. They visited fjords, went overland through Norway, and thence to Copenhagen. Their fifth Viking trip is planned for January 31, 1985, a segment of the around-the-world-trip. They board in Los Angeles and 38 days later leave it in Hong Kong. They are avid bridge players and have taken lessons from **Bill Post** in the New York area. Henry keeps active in his charities and reserve officers association, from which he has received several awards. He still keeps up his interest in various wine and food societies and thus has acquired a fair knowledge of oenology. Henry and Bea are looking forward to the 60th reunion.

We are indebted to Mrs. James Donovan (Jim is class of 1928) for information regarding a reception and dinner given for her stepbrother, **Roland Seabury,** on last August 11, in honor of his 80th birthday. Roland's son and daughter assisted by two young grandsons put on a grand reunion of old friends and neighbors—decorations, cards, gifts, and delectable food—all of their own composition.—**F. Leroy (Doc) Foster,** Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26

As we write the brief notes for the November/December issue of the *Review*, summer is drawing to a close with its usual scarcity of news from our classmates. Having recently completed a preliminary study of a power plant cogeneration project for a New England university we found time hanging heavily on us and began experimenting with a computer program on that subject. Results so far: the capability of determining the electric generation potential of a power plant with varying steam output and varying pressure requirements for heating and air-conditioning loads.

Notice has just been received of the schedule of the Boston Seminar Series, the theme of which will be the revisiting of the great "Mid-Century Convocation" held in 1949 on the occasion of **Jim Killian**'s inauguration as president of M.I.T. The last of the six events to be held at the M.I.T. Faculty Club on April 8, 1985 will feature an address by Jim on "Obligations and Ideals of an Institute of Technology."

Peter Bellaschi, apparently well-recoverd from his recent surgery writes with enthusiasm of the activities of M.I.T. people in the affairs of the IEEE Power Engineering Society. Of 42 medals awarded at the centennial meeting this summer six of them were given to M.I.T. graduates or professors, including of course, Peter. . . . A letter from **Juan T. Villanueva** of the Philippines tells of his return for a visit to M.I.T. after an absence of 58 years. It is good to know that guided tours of the Institute are available every weekday at 10 a.m. and 2 p.m. leaving from the Information Office, Rm. 7-121—an interesting possibility for those of us who are not familiar with the tremendous changes which have occurred in the near 60 years which have passed. We advised Juan of those possibilities and asked to meet with him for lunch or dinner so that we can report to you of his experiences in the hectic period in which he has lived in the Islands.

As a result of the Alumni Register questionnaire a delayed notice of the death on September 29, 1983 of **Edgar B. Godley,** survived by his wife Helen, was received. . . . An alumni mailing disclosed the death on June 10 of **Judson T. Biehle** of 332 Kelly St., Hawthorne, N.Y., survived by his wife Reba. . . . Another alumni record discloses the death on May 13 of **George W. Breck** of 900 Intracoastal Dr. Apt. 7, Fort Lauderdale, Fl., survived by his wife. To the widows of our classmates we express our sympathy and a reminder that they are invited, as in the past, to come to our 60th reunion to meet again and share memories of our youth.—**William Meehan,** Secretary, 191 Dorset Rd., Waban, MA 02168

27

Your secretary apologizes for missing last months' notes. Ruth and I were in the midst of the moving process after 40 years in our Milton home. With the accumulation of furniture, knick-knacks, innumerable books, and files of papers that somehow become part of the accouterment of living today, we are in our family homestead in Epping, N.H. A new life style is evolving—earlier to rise with a full day of potential activity, calculating the most efficient way of getting things done.

We enjoyed a visit with Louise and **Franklin T. "Hank" Kurt** in S. Brooksville, Maine early in the summer. He has received many favorable comments from readers of his book, *Water Flying*, a documentary on amphibious aircraft, which he wrote eight years ago, now in its second printing. Off and on he works on writing another book.

George D. Fexy of Kirkland, Wash. says he was an obscure civil engineer, but his record disproves it. After enduring the ROTC engineers training, he was ordered to duty as first lieutenant in 1942 and discharged as lieutenant colonel in 1957. He participated in seven campaigns in Europe and was civil affairs military government officer in occupied Germany until 1949. Subsequently he worked on the construction of the DEW line project in Labrador. As a semi-retired engineer, George is presently active in developing Bear Creek Country Club, an 18-hole golf course with 300 residential lots in Redwood, Wash. Thanks for the notes, George.

Robert C. Wallace wrote of the death of his lovely wife Barbara in May, having suffered several years as a victim of Alzheimers' disease. They had 56 years of happy life together. I well remember her as the vivacious girl who squinted her eyes when she laughed. We send our deep sympathy to Bob and his family.

From aboard Flying Gull in Bucks Harbor, Maine.—**Joseph C. Burley,** Secretary, Box 416, RFD 3, Epping, NH 03042; **Lawrence B. Grew,** Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole,** Assistant Secretary, 2150 Webster St., Palo Alto, CA 94301

When Ernie Knight, '28, began cutting up a huge oak tree on his timber farm in a densely forested area of Raymond, Maine, this cock partridge perched on his chain saw. On one of it's many return visits, the bird posed for photographic proof of it's friendliness.

28

Promptly after the August/September class notes were issued, we received a letter from **Roger Haven**. He expressed much surprise at finding his picture and the photograph of his iceboat in the '28 news section. So let this be a lesson to all you retiring '28ers out there—when you write to your class secretary almost anything can happen and sometimes does (as we have seen). Roger also wrote that he had seen and talked with **Jim Tully** recently in their hometown of Fryeburg, Maine. Apparently Jim was in good spirits and enjoying his summer stay there. . . . Enclosed with Roger's letter was a clipping from *The Bridgeton* (Maine) *News* for August 2 with an interesting story about **Ernie Knight**. Ernie and wife Louise live in a densely forested area of Raymond, Maine. It appears that Ernie had been working on his timber farm to cut up a huge oak tree for firewood. A wild cock partridge decided to join him for companionship and stayed close by even to the extent of hampering the cutting operations. As this association went on for eight or ten days, Ernie tried several times to tell his neighbors and friends about the overly friendly bird. All he met with were knowing nods and side glances. So he took his camera into the woods and photographed the partridge as it perched on the handle of his chainsaw (see photo above). Now he has the clean-cut evidence to show the chain of events and to prove that the bird was no wild tale. Never doubt the veracity of a true '28er!

Next to **Bill Hurst, George Chatfield** is perhaps our most consistent correspondent. A recent letter from George, accompanied by appropriate news clippings, covered several subjects and included the following: In the early summer George and Marie spent an exciting three weeks in England. This was in connection with the week-long 1984 Rotary International Convention held at the new Birmingham Convention Center. However, the highlight of the entire trip was a luxury bus tour of England by 40 Rotarians and wives from six countries: Australia, New Zealand, Canada, U.S.A., England, and the Netherlands. The special tour was so organized that the group was wined, dined, housed, entertained, and guided by members of the Rotary clubs through dozens of English and Welsh cities and towns. It was felt that the trip did much to promote better international understanding.

A note from **Frank Sweeney** tells us that he still keeps busy with golf, yard work, and a microcomputer. He works as a county coordinator of the Tax Assistance for the Elderly program, then vacations in Florida in late winter when his work is done. This year he met with the **Carroll Smiths** and the **Jack Rouleaus** while in Florida. . . . In a telephone conversation **John Melcher** said that his attendance at Technology Day in Cambridge this year was a most pleasant experience and he was very happy to see those classmates who attended. . . . **Jim Donovan** is (and has always been) one of our most effective reporters. In recent months he has been in telephone or letter contact with **Nap LaCroix, Al Daytz, Ed Walton,** Helen (Mrs. **Robert) Harris,** Claudia and **Maury Klegerman,** Jan (Mrs. **John) Chamberlain** Sawyer, and Mary (Mrs. **Arthur) Nicholas.** We hope this will stimulate these vice-presidents and honorarries into writing their own class notes news. . . . And while we have **Jim Donovan** in mind, hearsay has it that he is about to receive a highly distinguished professional honor. Perhaps by the time of our next writing the award will have become a fact and we can report on it.

With deep regret we must report the deaths of three classmates. **Thomas E. Garrard** died on August 23, 1984. A copy of his obituary notice was very thoughtfully provided to us by his friend, William J. Sherry, '21, who commented that Tom was always a strong and loyal supporter of the local M.I.T. Club. Tom graduated in Course IX-B, general engineering, and in his earlier professional career was an engineer for the Texas Co. In his later years he was, successively: engineer, vice-president, and board chairman for the McAlester Fuel Co., McAlester, Okla. He had wide civic interests and activities and was a founding life member of the M.I.T. Sustaining Fellows. Tom's wife, Allece, survives him. . . . **John B. Pearson, Jr.,** (rear admiral, U.S. Navy, retired) died on March 23, 1984. John was a graduate student with us in Course XIII-A, naval construction. In his 40-year report to the class, John stated that he was then retired from North American Aviation as vice-president and also retired from the navy. Information on his death was sent by his daughter. . . . **Raymond L. Woford** died July 20, 1984. His wife, Edith, was both kind and thoughtful in writing to us. Ray had been recovering from a successful triple bypass heart operation when, after only two weeks, he had to undergo emergency intestinal surgery. He survived this second operation by only one week. Ray graduated in Course IV, architecture, and worked for various architectural firms about the country during his early years. He then went with National Biscuit Co., where he was manager of branch buildings until retirement after 35 years of service. We extend our heartfelt sympathy to the families of these classmates.—**Walter J. Smith,** Secretary, 37 Dix St., Winchester, MA

29

Correction: Our apologies to **John Happel** of Hastings on Hudson, N.Y. for a typographical error in his name in the August/September 1984 issue of the *Review*.

Arnold W. Conti of Atlantic Beach, Fla. sends a note, "Thanks for my usual March birthday card. Chronologically, I am only 77, but I have days when I feel that plus my golf score. Our life has pleasantly settled into a routine—some travel and an occasional burst of excitement prompted by a trip to the drugstore with a new prescription, hoping it will revive the vigors of 50 years ago and later thankful that it didn't. We have a group of about 30 retired executives from all professions who have taken over the management of our faultering country club and have pretty much revived it. On Mondays we gather at the club to do actual physical improvements—we paint, plant, build bulkheads, etc. We have enough projects programmed to last us for the next five years. I estimate that we have saved about $100,000 in design and labor costs over the past three years. In return, the club gives us a free lunch that day. At this point, except for the mortgage and current expenses, we are debt free. I was elected director of construction, and in return for this highly regarded honor, I have been freed from the shovel brigade. We are considering a special club membership to be offered to the snowbird golfers from the North from January through March at attractive rates. Anyone interested please write to me at 1820 Sevella Blvd., Atlantic Beach, FL 32233." . . . **Seymour A. Baum** of Jupiter, Fla. is thoroughly enjoying his retirement life with his wife Claire. He says, "We will be heading for the Canadian Rockies in a few days. We thank the Lord for our continued good health. Many thanks for remembering my birthday."

John G. Sullivan of East Dennis, Mass. states, "I was sorry to have missed the 55th reunion. The radiation therapy program that I am on sort of knocks my system out of kilter temporarily. However, I have only ten treatments to go, and then I expect to be back in high gear." John was a reunion committee member for our 55th and acted as **Jerry Gardner**'s contact man at the Cape. He does volunteer work at the Cape Cod Hospital and likes gardening and plays golf. . . . **L. R. Bill Aldrich, Jr.,** of Billings, Mont. writes, "Brace yourself—after so many years I am letting you know that I have appreciated receiving remembrances of my birthdays and I could no longer ignore sending this note. Old age is creeping up on us all, but I keep busy doing whatever I can, as I have done all my life. I feel good and get around pretty well, but am doing less and less as time goes on. My oldest boy is now taking care of most of the business and my blind son who played the piano at our reunion at Bald Peak, has worked himself into being a very good purchasing agent. He spends a lot of time with ham radio and has very little time for music. Just received word that my old roommate, **Robert W. Gray** has passed away suddenly on April 27. Many thanks for all the things you have done for the Class of 1929."

John Tomfohrde of Somerville, Mass. states, "There is never anything new—just routine, working five days a week and around this time of year (summer) my wife Naomi and I spend our weekends at Cape Ann." . . . **A.J. (Jack) Dietsch,** of Sonoma, Calif. writes, "Many thanks for the birthday card from the Class of 1929, which you have been sending me and others for many years. Such a card is like a handshake across the miles of space. In our youth, we had no time for anything except college, profession, raising a family, making money, etc. Now that we have retired, we have time for meditation. 'Salutation to Dawn' in the birthday card says it all. We live day by day, thankful for our good health. My wife Klea and I take daily walks with our two dogs that we got from the local dog pound. They both are very affectionate and much attached to us. I am still active in volunteer work for senior citizens, helping with their 1040 forms at tax time. I have just completed my tenth year as tax aide. It has been very rewarding to help old people who are easily frightened by IRS and its requirements. Our biggest event is coming soon—the Democratic National Convention in San Francisco. Sanoma is only 40 miles from the convention. Regards to all."

A letter from **Sears Hallett** and his wife Dorothy was sent to **Bill Bowie,** president of our class, just before our reunion. He says, "It is a real disappointment that we will not be with you at our 55th reunion. We had been looking forward to attending this one and enjoy being together as we had during all the previous '29 class reunions. I am a director of the Barrington board of realtors and currently vice-chairman of the realtors' political action committee for the state of Illinois. Our job is to raise $295,000 from individuals and realtors to be used for campaigns of state and national legislative candidates. I am the federal district coordinator for our U.S. representative in the 12th district, and there is a state meeting in Springfield, Ill. from June 5-7, which conflicts with our reunion schedule. We would much rather be at the Chatham Bars Inn. Our very best wishes to all." . . . During the 55th reunion when **Frank Mead** and his wife Mary announced the death of Joan Gale, an appropriate sympathy card was circulated around and each of those present signed it. **Bill Bowie** and wife Sally volunteered to deliver the card personally to **Wally Gale** at his residence in Melvin Village, N.H. When they arrived there, they were shocked to learn from his daughter that Wally was terminally ill and not able to see anyone. She also told the Bowie's that her mother had died peacefully in bed while reading. A short time later a second note from Bill announced the death of Wally on July 11, 1984, a little over a month after his wife had passed away. Most of our classmates know that Wally's career was closely associated with M.I.T. and that the Gales almost always participated in all reunions and functions. Wally was in the naval reserve during World War II, later joining the M.I.T. faculty in aeronautics in 1946. He remained on the faculty until 1958 and served as secretary of the Institute as well. In 1954, he became administrative associate, a position he held until his retirement in the mid-sixities. During his tenure at M.I.T., Wally originated the summer session, and James R. Killian, Jr., '26, former president and chairman of M.I.T., gave him carte blanche to design a broader summer session with conferences, seminars, and courses for representatives from industry, government, and other institutions. The summer session he designed has prospered greatly. In 1983, almost 1,500 individuals from the U.S. and abroad attended 46 separate programs. He is survived by a son, Thomas S. Gale, of the U.S. International University in Nairobi, Kenya, and a daughter, Joan I. Gale, of Melvin Village, a former staff member in M.I.T. Design Services. . . . I also regret to announce the death of **John F. Dexter** of Pompano Beach, Fla., a former resident of Marblehead. He was a member of the National Railway Historical Society, the White Mountain Ski Runners Club, and the Eastern Yacht Club of Marblehead. He leaves two sons, navy commander Stephen Dexter and Robert Dexter, and two grandchildren.
—**Karnig S. Dingian,** Secretary, P.O. Box 83, Arlington, MA 02174

30 55th Reunion

Amplifying the brief statement in the October notes retracting my erroneous report in the August/September issue of **Tom O'Connor**'s death, such errors, are, of course, inexcusable, but are sometimes at least explainable. Shortly prior to the time I prepared the August notes, I received from M.I.T. a "Deceased Alumni Information" form reporting the death of **Thomas Connor,** who is listed in the *Alumni Register* as a member of our class and who, like Tom O'Connor, lived in a Boston suburb, was involved in the construction business and had a son Thomas Jr., who reported his father's death. Having seen Frances and Tom O'Connor at numerous reunions and having no recollection of classmate Connor, I apparently inadvertently read the missing "O' " into the form that I received from M.I.T. with quite unfortunate results. My apologies to all of you for this error.

By the time these notes are published you will probably have received a first mailing concerning the 55th reunion. According to my present information, it is contemplated that we will get together at the Colonial Hilton in Lynnfield, Mass., near Route 128 north of Boston, on June 8-11, 1985. I suggest you make a note of these dates. Further details will appear in later issues.

Greg Smith has now completed 12 years of volunteer work at M.I.T., mostly on the Undergraduate Research Opportunities Program, but more recently on the Council for the Arts. His work on these programs takes him to all parts of M.I.T. and has greatly increased his knowledge of and respect and enthusiasm for the Institute. Also he

has delved quite deeply into photography, going so far as to study with Ansel Adams and Paul Caponigro. He works entirely in black and white, except that he uses color film when he and Doris travel. He has continued to ski at Pico, Vt., and Alta, Utah, but is now somewhat more careful than he formerly was. . . . **Jay (Cappy) Ricks** and his wife "Tommy" shuttle between Thomasville, N.C., and Lighthouse Pt., Fla. They celebrated their 45th wedding anniversary with a six-week trip around the world by Panam. Cappy is a real estate consultant and exclusive agent for some Arab investors. He has been president of their Florida condo for the last five years.

Last June Anne and **Tul Houston** visited Cynthia and **Bob Reynolds** in Centerville, Mass. Bob is still working for Packaging Industries, Inc. in Hyannis. In July Tul celebrated his 75th birthday in Scotland, where he was born. The Houstons took their son and daughter-in-law to Scotland to meet some of Tul's cousins who still live there. Tul is active in the newly-organized town of Hilton Head Island, especially in trying to "curb the over-building which will ruin the place if they don't." Golf, swimming, and sailing keep him in pretty good shape. . . . **Mel Blackwood** was honored last May at the 677th meeting of the Northeastern Section of the American Chemical Society (ACS), held at Simmons College in Boston, in recognition of his 50 years of continuous membership in ACS. Mel spent most of his career in research and development of textiles, to improve their washability, crease-resistance, shrinkage-resistance, and electrical resistance. For a time he worked as a plastics engineer on the Apollo program. After semi-retiring in 1970, he taught math and science in Sanbornton, N.H., where his wife Leola was a public school teacher. He and Leola are now fully retired and shuttle between Florida and New Hampshire.

Tul Houston has called my attention to the fact that **Jack Osborne** died in Chatham, N.J. last April. Jack worked for M.W. Kellogg (now Pullman Kellogg) for about 40 years, mostly in the process engineering of petroleum refining plants. He retired in 1971 when the company moved its headquarters to Houston but continued to do consulting work for the company thereafter, including numerous assignments. He is survived by his wife Lydia, three sons, a daughter, and six grandchildren.—**Gordon K. Lister,** Secretary, 294-B Heritage Village, Southbury, CT 06488

31

A letter from **John Swanton** dated July 30, 1984 reads as follows: "**Art Fuller** called on Louise and me here at Westport (Maine) yesterday. I hadn't seen him since the 45th reunion. He looked well but lost his wife Lois (cardiac arrest) last August, and it was a struggle. That's why they missed the 50th. He still lives in Woburn, Mass. His older daughter, Joan Brock of Limerick, Maine, was with him yesterday. She is not too far away and can give him some companionship. Elaine, the younger daughter, is in Ventura, Calif. He now has six grandchildren and one great-grandchild. Art and Lois had their 50th wedding anniversary four years ago (three years ahead of Loretta and **Enio Persion** and four years ahead of us!) They eloped during college days." Many thanks to John for the newsy letter. . . . A note, dated July 9, 1984, from Colonel **Fred Elser**: "Three months of disruption and now finally a place again. Still not unpacked and am afraid the 'ham radio' will (when it gets on) be confined to about 100 watts of 40 meter cw with a whip antenna or equivalent. We had made plans to go to Georgia (where Fred Jr. and family live) as early as the first of the year, since our apartment in Honolulu (home for over ten years) has been bought. The death of Donna, leaving Fred, Jr. with two teenage sons to raise, confirmed our decision. Fortunately, we came to the mainland on May 3, since Janet in Honolulu soon after was rushed to the hospital with serious surgery impending. Margy flew from California, and saw Janet through successful surgery." (Note: Fred failed to include his address in the note.)

Charlotte and **Ed Hubbard,** Loretta and **Enio Persion,** and Ben and his good wife Clare were at Louise and **John Swanton**'s 50th wedding anniversary. The temperature broke all records for heat that day in New England says John. One hundred sixty four signed the book in spite of the heat.

Following is part of this report that I least enjoy. A number of our classmates wrote me of **Art Newell**'s death, and according to the newspaper clippings sent me, Art had a brief illness. However, **Randy Binner,** who probably knew Art as well as any of our classmates, wrote: Art Newell died, but hardly after a brief illness. He had been ailing for years, but his big smile and happy disposition covered almost constant pain. I remember being in the common toilet room at our 45th when he was taking a shower, and the scars from various operations made him look as if he had been badly wounded in action. One of his problems at our 50th and the Alaska cruise was that he could not eat anything after noon or he would be awake all night from stomach problems. He was legally blind and in need of a hip replacement, but the doctors said he would not survive the operation. Despite these problems he was with us on the cruise and I am sure enjoyed it very much. He and Sally celebrated their 50th wedding anniversary this spring. There are two addresses: 27 College Rd., Wellesley, MA 02181, and P.O. Box 153, Jackson, NH 03846.

Other deaths reported since our last notes are **Frederick Simmons,** who passed away as of April 1, 1980; **Thomas R. Stearns,** on June 10, 1984; and **Morley G. Taylor,** on May 7, 1984. Unfortunately, Art Newell is the only classmate on whom we have more details, thanks to Randy Binner. Our sincere condolences to all of the families.—**Edwin S. Worden,** Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John R. Swanton,** Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman,** Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02360

32

As we go along in our advanced years, there is always the question of contentment with our life's work and peace of mind in our last few years. I am grateful to Charlie Huisking, a *Sarasota* (Fla.) *Herald-Tribune* reporter, who gives us the story of one of our own classmates, **Jacob Millman.** "Longboat Key resident Jacob Millman has just learned he is in some illustrious company. Along with such prestigious figures as Thomas Edison, Alexander Graham Bell, Guglielmo Marconi and David Sarnoff, Millman has been elected to the Electrical Engineering Hall of Fame.

"A Columbia University professor emeritus, Millman is one of 30 educators, inventors, and industry leaders so honored by the Institute of Electrical and Electronics Engineers (IEEE). The IEEE established the Hall of Fame this year to mark its 100th anniversary. The selections, announced in a recent issue of the IEEE's magazine, were based on a poll of the organization's 150,000 members.

"Millman has long been a highly respected member of the academic and scientific community. He taught electrical engineering and computer science at Columbia from 1952 until his retirement in 1976. But his influence extends far beyond the Columbia campus. He has written eight textbooks that are used in engineering, computer science and physics departments at leading U.S. and Canadian universities. The international student editions of his books serve as the basis for electronics courses worldwide." Here we see a man who can look back on his life and say, "It was good." And he now enjoys his retirement with his wife, his hobbies, and his family.

Eleanor and **Ed (Bunny) Nealand** had a good winter in Florida and are now enjoying Cape Cod this summer. They quite often see Phyllis and **Don Brookfield** and Midge and **William Pierce.** They may have some suggestions for our class activities to announce soon. Bunny says our classmates are very active in the M.I.T. Club of Cape Cod. . . . **Al Dunning, Joe French,** and **Willard Foster** are spark plugs in the organization. . . . **Robert Moore** tells us that he has been with Western Electric since 1941. He is now enjoying retirement.

We have information that **Bertil A. Franson** died on June 11, 1984 at Union Hospital, Lynn, Mass. He had worked for 35 years as superintendent of the Standard Duplication Machine Co. He retired in 1968. His hobbies were yachting and bowling. He leaves his wife Lona, two sons, and eight grandchildren.

We also learned that **Oliver Morfit** died on June 5, 1984. . . . All for now.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33

Correction: We apologize to **Gardner Harvey,** who was reported deceased in the August/September *Review.* To the contrary, he is "alive and well and fit as a fiddle (but ready for the devil.)" This is good news indeed. We hope to hear from him further regarding his current activities.

Here it is winter again and our classmates have started to Florida again. There are advantages in living there, like weather and group meetings of M.I.T. men. You can get the times and places by writing to the Alumni Office. . . . **Bill Bauer** writes, like a good man, saying he plans to go to Europe for six weeks and will visit his home town near Stuttgart and see his cousins. He had a letter from **Ellery Clark,** who lives near Los Angeles, enclosing a picture of **Gus Liljergren, P. Lobdell Ellery Clark** and Bauer made at the 50th. The Clarks were scheduled to go to Washington State where they would see Gus. Bill has attended a number of Mexican alumni festivals and helps arrange the biannual Florida festival.

Old reliable **Jack Andrews** wrote from Nags Head, N.C., where the Wrights made their early flights. He and Jermain were part of 12 at the beach near where Sir Walter Raleigh's colony landed over a century before the Pilgrims came to New England. He and Jermain are both well and busy with AARP, among other things. . . . **Clarence Westaway** wrote that **Bill Barbour**'s daughter married in midsummer. . . . The **Beau Whittons** spent the summer in the Blue Ridge Mountains and were expecting a grandchild about Halloween.

Many of you extend congratulations to Frances and **Warren Henderson** on their marriage last spring. . . . **Bob Trimbie,** living in Pensacola writes that **Norm Spofford** lost his wife last spring. Norm lives at 3845 Potosi Rd., Pensacola.

Walt Duncan, retired in the Philadelphia area, says he and Janet will never attend another grandson's Yale graduation unless clear weather is guaranteed. . . . **Fred Murphy,** after promising to send news, finally did. He saw **Dick Morse** at a Cape Cod Marina; he saw **Bob McCormack** at a cocktail party after 50 years. Those Tech friendships do last! Bob was with Raytheon for many years as vice-president of manufacturing and traveled worldwide for them.

Anne and **Fred Murphy** see the **George Stolls** occasionally and went cruising with them in the British Virgin Islands last winter. George's Jane had surgery last spring, and their trip to Scandinavia was postponed. She is well again, and they are planning to go to the Pacific Northwest. . . . **Clarence Westaway** is still working with Ingersol-Rand, among his boilers and such things. . . . **James H. Merritt,** who lived in San Francisco, died last spring, and **Cornelius J. Griffin, Jr.,** living in Oxnard, Calif., who came to M.I.T. from Holyoke, Mass., died in early summer.

The new alumni directory is now available. If you have not ordered one, you can do so by writ-

ing the Alumni Association (attention Diane Monahan) Room 12-090, M.I.T., Cambridge, MA 02139. . . . How about a report from you? I heard that we are all individualists at heart: Everyone likes to peel his own banana.—**Beaumert Whitton,** Secretary, Cottage 112, Sharon Towers, 5150 Sharon Rd., Charlotte, NC 28210

34

The compassion that you find among fellow-sufferers is wonderful. I received a note from Beaumert Whitton (secretary of '33), passing a copy of a letter from our **Walter Wise** explaining why he, Walter, could not follow Beau's advice and go to our recent reunion. Since Walt won't write to me, I'll pick out some of what he said in the letter he did write. He mentions that one of their two daugthers lives overseas with her family. In late May and early June (hence no reunion) Walt and his wife visited their daugther in Luxembourg. Her husband is a lawyer with the European Investment Bank and since Walt's visit the family has been moved to Greece for a three-year assignment.

Walt noted that he has retired as president of a local cutting tool manufacturer but stays active in a new career—selling industrial real estate. He says he's busy and having fun.

My thanks to Beau Whitton for this item and let it be a warning to all as to how supportive (and devious?) our class secretary network can be.

I also had a brief letter from **Ed Asch,** in part expressing his appreciation for the way the reunion had been carried off. He said that since he wasn't flying with the crows, he managed to spend four weeks and drive 4,500 miles getting from Houston to Boston and back. Ed and his wife were planning a trip to China, Korea, and Japan to start the first week in October. He asked for **Wing Lem Wu**'s address, which I could give, as Ed hopes to be able to see him.

There is one more of the seemingly inevitable losses to report; that of **William Barry** of Hampton, N.H. His death was on November 6, 1983, with no further information. I would extend our sympathy to Mrs. Barry and their family.

I've been around Brewster for four months now, a record for this year, so I'm about to hit the road again. On September 2 I'm leaving for five weeks in England again. I've never been there at this time of the year and the center piece for this trip is a week on a canal boat from Wales to Chester—to cover 61 miles in 6 days! The boats carry ten passengers, presumably all strangers, so I'm hoping for decent weather or even dispositions; preferably both. There will be about ten days in London and two weeks in Devon and Cornwall with a car. As soon as I get back I'm heading from Ottawa for a model show, so I suspect that the notes for the next issue will come from George Bull.—**Robert M. Franklin,** Secretary, P.O. Box 1147 (620 Satucket Rd.) Brewster, MA 02631; **George G. Bull,** Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815

35 50th Reunion

Eleanor (Mrs. **Paul) Germond** in acknowledging my message sent me additional information about Paul that I would like to share with you. He developed the explosion-proof Go-Getter fork truck required in many chemical, refining, and pharmaceutical industries in the U.S. and abroad. He was well enough last year to take a cruise through the Panama Canal and another from Vancouver to Anchorage. His cancer was in remission then. He was looking forward to his 50th reunion next year. Paul was past president of the North Jersey Manufacturers Association. He was a member of the Bergen County Society of Professional Engineers, the National Society of Professional Engineers, president of the Ridgefield Rotary Club, and a member of the Englewood Field Club and the Englewood Club.

I am currently in the midst of a leave of absence from Simon Relays USA. Personal pressures combined with the stresses of the day-to-day operations suddenly became too much to handle in early June. My golf is improved.—**Allan Q. Mowatt,** Secretary, 39 Congress St., Apt. 5, Nashua, NH 03062

36

By the time these notes are read I hope to have seen some of you in person. A note from **Larry Peterson** contained a clipping about **Bob Gillette.** Bob, chairman of the Board of the National Life Insurance of Vermont, has received the National Governors' Association award for distinguished service to his state. The award was presented by Illinois Governor James R. Thompson at the governors' conference in Nashville. He was one of five private citizens so honored. Bob has served on a number of state boards, including the Governor's Cost Control Council, the State Employees Compensation Review Board, the State Educational and Health Buildings Finance Agency, and is currently a member of the Vermont State Board of Education. In the mail a day or so later was an envelope from Bob himself. It contained nothing of the above but included a copy of National Life's company magazine with a beautifully illustrated account of the Gillette's Antarctic Odyssey. Jan and Bob traveled to Punta Arenas, Chile where they boarded the *World Discovery* for three weeks exploration of the Antarctic. Bob is a great sailor and has read extensively about the explorers of that region and welcomed the opportunity to learn more of it first hand.

Of himself, Larry writes that he has been in and out of the hospital with a series of medical problems but hopes "to stay patched together." He and Lillian escaped the long, hot, humid spell last summer by retreating to their camp on Great Sacandaga Lake about 44 miles from Schenectady.

In the last issue I reported the death of **Clarence Horton** and since then have received additional information but I feel I covered his accomplishments fairly well last time. However, I would like you to know that his daughter, Margaret H. Weiler, has a Ph.D. from M.I.T., which she received in '77.—**Alice H. Kimball,** Secretary, P.O. Box 31, West Hartland, CT 06091

37

Fred Altman of Fall Church, Va. continues hiking, square dancing, and attending concerts. He went to Europe in April 1984. His son has been named "chevalier de l'ordre des palmes academique" for his work on cultural interchange. . . . **John Clinton Robbins, Jr.** of White Stone, Va. writes that he is living on the same creek as the Tides Inn. He says, "The last nine years here have been the best of my life." . . . **Lewis P. (Pete) Reitz, Jr.** of Palos Verdes, Calif. retired in 1973 as head of the electronics department at Technicolor, Inc., Hollywood. He is now an electronics consultant, self employed. He is founder of Big Bands Associates, an organization which has monthly luncheons at Variety Arts Center in Los Angeles. Guests have included Woody Herman, Red Norvo, Frank DeVol, Nat Pierce, and Van Alexander. The group is three years old and going strong. Travels have included Hong Kong and Japan in the last five years. He has one son, Philip, who works with him on printed circuit card designs and layouts. He has also produced two big band albums within the last year: Pat Longo's "Billy Man for President" with Frank Sinatra, Jr. (part interest) and Roger Newmann's rather large band on Sea Breeze label (co-producer). Records don't make any money but are a hell of a lot of fun to make.

Leonard Seder of Lexington, Mass. is still going strong with his consulting practice on quality control. Leonard was a pioneer in quality control management and engineering. Currently, demands for his service are greater than ever, and he appears to have no firm thoughts of retiring. On July 18, 1983 grandson Nathan was born to daughter-in-law Jean and son Bob. Daughter Judy and children, Anat (14) and Nimrod (8), visited the U.S. from Israel (where they live on kibbutz Beit Zera near Tiberias) and spent time with Leonard and Genevieve in both Lexington and Dennis, Mass. On July 18 a triple birthday party was held in Dennis for Leonard (69), Nimrod (8), and Nathan (1), who were all born on July 18! Leonard and wife Genevieve are playing duplicate bridge two or three times per week. . . . **Herbert K. Weiss** of Palos Verdes, Calif. retired June 22, 1983 as a senior engineer with Litton Systems; his current position is "relaxed." He was awarded the USAF Commendation for Meritorious Civilian Service. His wife Ethel is deceased. . . . **William J. McCune, Jr.** of Lincoln, Mass. is chairman and chief executive officer of Polaroid Corp. He is a fellow of the American Academy of Arts and Sciences and the National Academy of Engineering. He is also a trustee of the Massachusetts General Hospital. His hobbies are skiing, cycling, woodworking, and silversmithing. He has a second home in Switzerland. Wife Elizabeth's main interest is painting. He has three children and three grandchildren. He writes, "See you all at the 50th."

It is with deep regret that I report the death of **David C. Hill** of Flintridge, Calif., who passed away May 17, 1984.—**Lester M. Klashman,** Assistant Secretary, 289 Elm St., Apt. 71, Medford, MA 02155; **Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, MA 02155

39

Mary and **Jim Barton,** mayor of Hunts Point, Wash., entertained friends and neighborhood voters at their shoreside home on Lake Washington for their traditional July 4 barbecue. During the balmy pleasant evening, we all sat on their outdoor deck to view the hundreds of motor cruisers anchored below and the spectacular fireworks display on the opposite shore. . . . Billie and **George Cremer** drove their spacious motor home round trip from Lemon Grove, Calif. to Lake Louise, Canada. En route they visited the **Ben Badenochs** near Los Angeles, the **Seykotas** in Tacoma, and **Jim Bartons** near Seattle. We enjoyed their visit in Tacoma and witnessed a minor miracle as Billie Cremer prepared for five in her miniature mobile home kitchenette—a tasty dinner including a lasagna casserole, toasted garlic bread, and a molded jello-and-fruit salad.

Anne and **Fred Schaller** made a vacation circle of the north shore and returned to their historic homestead near Wellesley, Mass., where they found their daily panhandlers remembering to appear promptly for their handouts at 5 p.m. outside their sliding glass door. The panhandlers include a mother racoon name Charity and her four baby racoons. . . . Hilda and I continue house hunting, and when we find something suitable we inevitably find a significant difference between the price asked and that offered.—**Hal Seykota,** Secretary, 2853 Claremont Dr., Tacoma, WA 98407

40 45th Reunion

Limited news to report this go-around. Short note from **Alfred P. Barton,** Middleburg, Va., indicating that he had retired about five years ago but is still busier than ever with the small company he still owns, a charitable organization, tennis, etc.

Sad news to report on the death of **Roy M. Tuttle** from cancer on June 5, 1984, at a convalescent home in Windsor, Conn. Roy had lived in Windsor since 1952, and had been a structural stress engineer for Kaman Aerospace Corp. in Bloomfield for 33 years, retiring last October. He

had been very active in both town and church affairs. He is survived by his wife, Marjorie, three sons, a daughter, and a grandson. . . . All the news for now.—**Donald R. Erb,** Secretary, 10 Sherbrooke Dr., Dover. MA 02030, (617) 785-0540

41

Robert Wallace Blake wrote July 20 from Seattle about a wonderful Mediterranean Cruise of the M.I.T. Quarter Century Club. Richard Fleischer, '49, was also on board the *Illiria*. His report, a day-by-day description runs eight pages. There is not enough room to print it all, but if anyone is interested, drop me a line and I shall send a copy, especially if you include a tidbit about your own activities. You get the idea.

Bob Blake met **David Saxon** at the M.I.T. Club of Puget Sound in Seattle. . . . Cecily and **Ray Berry** stopped in Seattle en route home to Long Beach in their RV after an air and rail tour of Alaska. Ray said they stopped by Crater Lake, which neither he nor Cecily had ever seen. Alas, the day they arrived, snowdrifts were still piled up to 20 feet, and the rim of the crater was hidden in clouds. They still haven't seen Crater Lake.

William T. Butt called recently from Chatham Bars Inn and then came with his charming wife Ellen to have lunch with me and Peggy at the Beach Club at Centerville. We had a fine chance to get reacquainted. This is the first time a visitor has shown up since **Peter H. Smolka** stayed with us three years ago. Bill still runs his general contracting firm in Dayton, Ohio, specializing in industrial and heavy construction. Of his classmates he remembers with special affection **James W. Mar** and **John "Mel" M. Biggs**. His special request to readers of this column: the loan of a '41 class ring, in order to have a copy made. His address is 4501 Southern Blvd., Dayton, Ohio, 45429.

Jacob Berezow of Silverspring, Md., died March 26, 1984. He was a physicist at the Naval Surface Weapons Center. . . . **E. Kirland Miller, Jr.,** died in London on June 12. Kirk was a member of the M.I.T. Corporation and lived in Baltimore and in Aspen, Colo. After graduating he served as a supply officer in the Navy. He completed his M.B.A. at Harvard in 1950 and began his career with the Western Maryland Railroad. He then joined T. Price Row Associates, Inc. as an investment counselor in 1952. With perfect timing he was one of the originators of the famous T. Price Rowe Growth Fund. He became president in 1974. We remember him as a physical fitness buff and of very elegant appearance. It is interesting to learn that Kirk also loved to garden. He was president of the Baltimore Museum of Art and of the board of the symphony, and a director of the Pro Musica Rara, a baroque music organization. His wife, Ann Renshaw (Hoffman) Miller, survives him, as does his daughter, Mrs. Pamela K. Loya, and his son, Daniel F. Miller, of Billings, Mont. Both children are practicing attorneys.—**Joseph E. Dietzgen,** Secretary, P.O. Box 790, Cotuit, MA 02635

42

The "Dog Days" of August are over and so is most of the summer. There is no class news in sight anywhere. Not even a nice new retirement and, thankfully, no obits. Will have to resort to one yellowed, faded and tattered press release from our now completely empty file reserved for times like these. On second look, it is not all that old—only from May 12, 1984. **Bob Rines,** president of the Franklin Pierce Law Center announced a $7 million capital funds campaign as part of his commencement address. The announcement goes on to say that $2,107,000 has been pledged to date. Trust Bob not to have his neck out before he has money (or at least pledges) in the till! He should have graduated from Course XV, not from Course VIII! Herewith, my nomination of Bob as chairman of our 50th reunion Class Gift Committee. And it is not all that far off either.

Did have a pleasant telephone conversation with **Milt Platt** the other day. He is still executive vice-president at what use to be Fabric Research Laboratories in Dedham, Mass. Now called Albany International Research, reflecting consolidation of various Albany International companies under the prime corporate name. Albany International recently sold off some of their other subsidiaries but not Milt's operation. Guess he is making money for them. . . . Still play pinochle regularly with **Jim Stern** and with **Alan Katzenstein**. That game goes back (ugh!) almost 50 years to New Rochelle High School. Wonder just how much money has changed hands since then? Jim recently acquired a new grandson, giving him a total of two (one-sixth of a dozen assorted—the typical rich man's family). Alan and Rhoda's son was married last spring so they, at least, have some potential grand-offspring.

For XXX!!&&&&-sake, send news!—**L. K. Rosett,** Secretary, 191 Albermarle Rd., White Plains, NY 10605

43

It has finally happened—no news: not a card, letter, clipping, or obituary notice. A sorry situation, indeed, but not completely hopeless, since I have been saving up a few items of my own for just such an occasion.

At the 40th reunion, my wife Susan tried to recruit a number of the other ladies to attend a quilting seminar at Cazenovia College, N.Y., this past August. As it turned out, she and Leotas (Mrs. **Steward) Hill** were the only Class of '43 spouses fanatical enough to pack in with their sewing machines to absorb the latest in quilting high tech.

The week following Susan's return, she and I attended a reunion of my maternal grandmother's family, the Roushes. It claims the unique distinction of stemming from nine brothers, all of whom fought in the American Revolution. The total number of their descendants to date is estimated at 100,000, and over 200 of them showed up in Gallipolis, Ohio, to celebrate the 273rd anniversary of the family in America. I wore my 40th reunion cap, and suffered the humiliation of being asked in what state my military academy is located.

Enough for now. Please spare me the humiliation of having to write this kind of Class Notes again.—**Bob Rorschach,** Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44

John A. Tucker, Director, VI-A Program of M.I.T. noted recently that he met with **Walter W. Turner, Holton F. Harris** and **Will B. Rodemann** on Technology Day. There must be something about VI-A that its graduates manage to visit the department every time they are in the Boston area. Director Tucker was surprised to learn that Holton and Will had been stationed at the Army's Central Signal Corps Training Center at Camp Crowder, Mo., during World War II where he was also stationed. Perhaps you "shaftees" should make your relationship known to Director Tucker so he can know of a few more in your group.

Lawrence R. Klein who received his Ph.D. in chemistry in 1944 is Benjamin Franklin Professor of Economics and Finance at the University of Pennsylvania and chairman of the scientific advisory board at Wharton Economic Forecasting Associates. He recently became a director of W.P. Cary and Co., Inc., New York City, and he is chairman of Cary's Economic Policy Committee.

We regret to note that **Elizabeth Sheffield Cross**, who also received her Ph.D. in chemistry in 1944 died February 6, 1984.

Ruth and **Norm Sebell** entertained the 40th Reunion Committee at their home early in August. Attending to critique our most successful 40th Reunion were: Marguerite and **Ed Ahlberg,** Anita and **Les Brindis,** Priscilla and **Bob Breck, Bobbie Carpenter, Andy Corry,** Jane and **Lou Demarkles, Paul Heilman, Janice Kispert, Melissa Teixeira** and guest, and Edna and **Stan Warshaw**. It was noted that **"Bud" West** has agreed to chair a mini-reunion in Williamsburg in late October or early November of 1985. Mark you calendars now.

A letter from **Pierre H. Boucheron** notes the death of **Ed Tyberghein** of last November, 1983. Pierre also notes that he and Charlotte have retired to the vicinity of Charlottesville, Va., on 50 acres of woods.

Greetings of the Season—Happy Thanksgiving, Happy Chanukah, Merry Christmas and Happy New Year—from your secretaries: **Melissa Teixeira,** 92 Webster Park, West Newton, MA 02165; **Louis Demarkles,** 53 Maugus Hill Rd., Wellesley, MA 02181; and **Andrew Corry,** Box 310, West Hyannisport, MA 02672

45 40th Reunion

You should have received by now the initial mailing regarding our 40th reunion next June. As I pen these notes in late August, details are limited. I do know on August 1, **Tom McNamara,** reunion chairman, assembled the following committee members: Marie and Prexy **Gerry Quinnan,** Ann and **Bob Maglathlin,** Nancy and **Charlie Hart,** Carol and **Jim Pickel, Bill Meade, George Berman,** and Dee and **Frank Gallagher**. No decisions were made other than the appointment of absentee **Charlie Paterson** as sports chairman.—**C. H. Springer,** Secretary, Box 288, New Castle, NH 03854

48

Harry Jones called to discuss an acquisition candidate he is evaluating for one of his clients. A large corporation would like to sell this business with operations in the U.S., Europe, and South America. Harry and Ann have one son, Craig, who is president of his college fraternity. . . . **Bob Sandman** sent me a copy of the July 1984 issue of *New England Business*, which had a feature about **Sonny Monosson**. Sonny and his partner began a large used computer business in 1969, which Sonny has diversified into a company which sells and leases new computer equipment. He has been extensively quoted in the media including *Wall Street Journal* and *Fortune*. Sonny anticipated the time when new computer developments would rapidly depreciate the value of used computer equipment. He forced American Technology Appraisal Services to further diversify his organization before the downturn in the used computer market. Sonny publishes a regular newsletter on Digital Equipment Corp., *Monosson on DEC*.

Sonny's red suspenders and bow tie have made him a colorful character. He and his wife Gloria have four daughters. Sonny says he once methodically trained himself to sleep less: he cut back 15 minutes a week until he got down to three and one-half hours, then he worked back up. A regular squash player, he relaxes at his summer home, playing chess with longtime companions.

Gene Purdum continues consulting in solid waste disposal at an engineering firm. The new Resource Recovery Plant in Pinellas County, Fla. is converting about 54,000 tons per month of solid waste into ash, recovered metals, and saleable electric power. . . . **John Walch** continues as an educational counselor for M.I.T. and is on the board of the New Jersey State Council of Family Service Agencies. His son Jonathan was recently married, and John has become a grandfather. . . .

Gordon Pettengill, professor of planetary physics, has been named director of the M.I.T. Center for Space Research. Gordon is a pioneer in the application of radar techniques to the study of the planets. After graduating in physics with our class, he went on for a Ph.D. and joined the M.I.T. faculty in 1970. He began using radar to study Venus in 1961 and extended it through the inner solar system to the moons of Jupiter and the rings of Saturn in the mid-seventies. More recently, he led the radar experiment carried on the Pioneer Venus orbiter, which has revealed the complex nature of the Venus surface. The Venus Radar Mapper, a much more comprehensive mission, scheduled for launch in 1988, is under research at the Center for Space Research. The center is supported by NASA and also has some projects from the National Science Foundation and the Department of Defense.

Bill Kingery, professor of materials science and engineering at M.I.T. was recently elected to the American Academy of Arts and Sciences, a national honorary society founded in 1780 by John Adams and other leaders of the American Revolution. . . . **Bob Welsh** was made a director of BayBank Merrimack Valley, N.A. . . . **Bob Heikes** retired from National Semiconductor, where he had been a vice-president. . . . **Ed Hobaica** died at his home in Mystic, Conn. He was a senior engineer in the non-metallic section of the research and development department at Electric Boat. Active in community affairs, Ed served as chairman of the Town of Groton Sewer Authority. He served in the air force during the Korean War. On behalf of our class, I extend our sympathy to his wife, mother, children, and brothers.

After I (your class secretary) retired from Fram/Facet in 1978, I was in charge of technical operations at a company that manufactures elastic thread for two years. I opened my business, Productivity Management Co. (there is an easier way) in 1981 and have been a manufacturer's representative for a number of companies. Following three years of start-up effort, this year my earned income is climbing out of the basement. In March I added four companies with related products used to deposit thin films on semiconductor materials. Our largest vacuum chamber will deposit a thin film on 108 three-inch diameter silicon wafers at one time. We offer deposition equipment to evaporate, sputter, or ion bombard the material to be deposited. Last winter I qualified for Barrington's Frostbiting Fleet by sailing on 16 Sundays of the 24-week series. We race in Sunfish. This summer I am in my 15th year racing the International 110 sailboat. Our son, Laurence, was recently named general manager, corporate real estate for Pan American World Airways. Laurence reports to Gerald L. Gitner, vice-chairman of Pan Am. Our daughter, Amy, began interning after graduating from Harvard Medical School in June. Amy is in Seattle at a children's hospital affiliated with the University of Washington.—**Marty Billet,** Secretary, 16 Greenwood Ave., Barrington, RI 02806

49

In our last column we covered the Cambridge portion of our 35th reunion. Now we continue with **Paul Weamer**'s report on the Bermuda portion. "Saturday, June 9, awfully early in the morning we took a bus to Logan Airport for the American and Delta flights to Bermuda. Most of our wait was alleviated when Roz and **Stan Margolin** took all of us as guests to American's Admirals Club. Then, while in line at the gate, **Mickey Ligor,** well-directed by Pam, took pictures of various Boston Celtics.

"Bermuda: such a nice place. For Ginny and quite a few others, it was the water, it was sitting and talking, and drinking, and eating. For **Russ Cox,** it was keeping up with his two daughters, snorkeling, wind surfing, swimming, playing tennis, go, go, go! He's as old as I am; I don't know how he does it. Suzanne doesn't either, but she sure kept track of the three athletes! Tennis, it was wonderful. **Gene Wroblewski** is good, but you should see his wife, Lorrie—can she belt that ball! We were joined on the court by Kay and **Ed Kelly**. He is retired from Signal Oil and living in southern California. . . . **Blair Manning** just retired from Caterpillar after many years overseas. He and Emily will stay awhile in Peoria and then head to Ashville. . . . **Elda Chisholm, Frank Dineen,** and **Bob Walton** were our swinging singles. Elda, Frank, and Bob joined Blair, Gene, and me as the moped riders and wanderers. . . . Others in Bermuda were Dorothy and **Jim Christopher,** Kathie and **Bob Collins,** Barbara and **Wallace Douglas,** Nell and **Fletcher Eaton,** Verne and **Herb Federhen,** Daphne and **Warren Fisher,** and Betty and **Bob Griggs.**

"Since we were in Bermuda over the queen's birthday, we had an interesting visit to Hamilton to see the parade and the governor general inspecting the troops. Frances and **Bob Hughes,** Sunny and **Frank Hulswit** (our new class president), and Priscilla and **Dave Keniston** were there. Dave has just retired from Jones and Lamson in Springfield, Vt., and now plans to raise beef cattle. . . . Doris and **Mal Kurth** were there. He has retired from GE in Pittsfield. His plans: cut firewood, fish, golf, and ski. . . . Roz and **Stan Margolin,** and Jean and **Harry Lambe** have been to the Inverurie so many times that they acted as unofficial hosts and guides. . . . **Dick Marlowe** has also just retired from GE. He and Nancy are from Clinton, N.Y. . . . Marge and **Dave Moore** came directly to Bermuda from their Maryland home. It sure was good to see our Washington D.C. guides again. . . . Others with us were: Frances and **Don Ridgeley,** and Eunice and **Joe Schneider**. (What would the reunion committees over the years have done without their help?) We had a wonderful time. I'm sorry Ginny and I had to leave on Wednesday."

Your newly elected class secretary will begin with a column in the upcoming January 1985 issue. She is—**Barbara Powers,** Secretary, 39 Mt. Vernon St., West Roxbury, MA 02132

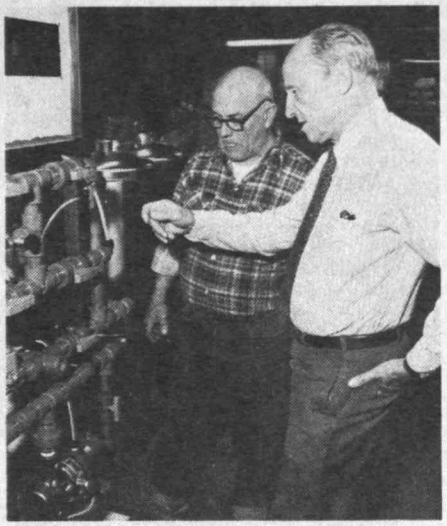
51

Merton C. Flemings is presently a professor and head of the Department of Materials Science and Engineering at M.I.T. . . . **Roy Weinstein** reports that in January 1983 he undertook the job of dean of Natural Sciences and Engineering at the University of Houston and more recently has been appointed a director and member of the executive committee of the board of directors of the Houston Area Research Corp. in Woodlands, Tex. . . . **Douglas F. Kaufman** states, "While currently trying to patent and promote new ideas for electric vehicle storage batteries, I am also working at IRS as a taxpayer service representative. Daughter Carolyn was married in Phoenix, Ariz. on January 1, 1984, and son Dana is soon to be married in Norfolk, Va."

Jim Russell's wife Maggie reports that Jim died in March of this year. He founded and was president of Minute Man Engineering since 1966. One of his last and most interesting projects was a 50-unit elderly housing project in Tewksbury, Mass., which was the first earth-sheltered project in the country financed by HUD. Mrs. Russell plans to continue operating the company with the help of their son, Jim, Jr., who is a 1977 WPI graduate. . . . We were also informed of the deaths of **Milton J. Merrin, Jr.,** and **Carl F. Huntsinger**. . . . **Herbert Levick** died in March 1984. He had been director of electronics engineering at Standard Motor Products in Long Island City, NY. . . . Our condolences to their families.—**Gregor J. Gentleman,** Secretary, 600 Holcomb, Suite 1, Des Moines, IA 50313

52

Colonel **Dan Lufkin** says that he is running an in-house computer store at National Oceanic and Atmospheric Administration (NOAA). As he observes, it is quite a change from Whirlwind II. He also teaches astronomy at Hood College in Frederick, Md. and does translations of technical books and articles from Norwegian and Swedish into English.



V. Carlisle Smith, '48, (right) president of Vaponics Inc. in Plymouth, Mass., checks out a water filter with worker Charles Gilbert. Vaponics manufactures water purification systems for the electronics, pharmaceutical, medical, institutional, and chemical industries. International sales account for one-fourth of Vaponics' revenues. (Photo: **Patriot Ledger)**

Our class president, **Art Turner,** has developed into a good manager. Just before leaving for vacation last summer (he was going sailing with his family on Nantucket Sound), he gave me an assignment. Avid readers of the class notes will recall that last year the Alumni Association found a misplaced account funded by insurance dividends from policies bought by several class members many years ago. Following the recommendation of a distinguished committee of classmates, the $20,000 fund has been used to endow a scholarship that will be awarded each year, starting this fall. Preference will be given to direct descendants of class members.

My assignment is to point out the following. Should our children or grandchildren in the years to come, ask for financial aid to M.I.T., they should identify themselves when they apply to make sure they are considered for this scholarship. Further, whether our progeny are potential beneficiaries or not, it is obvious that the annual income from the fund, though a welcome amount, is still small compared to current and future tuition fees. Therefore, when we contribute to the Alumni Fund, we should consider specifying that our gifts be used to augment the Class of 1952 Scholarship Fund. We will not only have the general satisfaction of giving where help is needed but the specific one of knowing what has become of our gift, for the class will be told who receives each scholarship. As I understand it, the student financial aid office will tell Art who the scholar is. Art will tell me, and in due course the news will appear in the class notes.

While for many of us the issue of financing a child's education is past, and that of a grand-

"The world is a terribly chaotic place," says Richard Powell, '50, "and two things give it order for me—music and physics." Above (right) he watches his Great Neck South High School (Long Island) physics students demonstrate linear acceleration with wagons named "FUMA Flyers," after the formula "unbalanced force equals mass multiplied by acceleration." Due to his novel teaching methods, the advanced physics program at Great Neck South has grown from nothing to 45 seniors, and 20 percent of the seniors have taken two years of physics. (Photo: **The New York Times***)*

child's has not arisen, we must all recognize the continuing need for help in obtaining a first class education. It is now our turn to contribute to this end.—**Richard F. Lacey,** Secretary, 2340 Cowper St., Palo Alto, CA 94301

53

This issue highlights four of our classmates who are working for Arthur D. Litle, Inc. in Cambridge, Mass. **John R. Ehrenfeld, George B. Hegeman, Richard S. Lindstrom,** and **William E. Hearne** are still doing similar work as project leaders/consultants, but in four different fields. In general, they provide consultive services to industry by assisting in such activities as planning for new ventures, expansions, acquisitions and mergers; helping with product development; conducting feasibility studies; and examining areas for diversification within that industry. John is responsible for the trash—his area is hazardous waste and other environmentally related industries, including the technology involved, the regulations that must be adhered to, the market for these services, and the pitfalls (such as availability of waste treatment and disposal sites).

Bill is into reading—he is helping printing and publishing industries in several areas listed above, while George is on a new high all the time—his area of expertise being the chemical industry. Finally, Dick is into an area that graduates have been encouraged to work at since before the sixties—plastics, of course. So, if any of you are over at A.D. Little, stop by and say hello to the guys. Or better yet, perhaps you can make use of their expert advice.

By the way, John and the others are part of the 78 percent of our class who work for a large company. However, Bill, at least, is one of the 30 percent minority working in a field unrelated to his degree, which was civil engineering.

We also received a brief note from Janet and **Mort Grosser,** who are living in Menlo Park, Calif., taking note of our unbroken year of 1953 class notes. They promised to send some news to put in these notes, but I note they haven't done so yet. Let's hear more from you folks soon.—**Wolf Haberman,** Secretary, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn,** Assistant Secretary, 289 Bronwood Ave., Los Angeles, CA 90049

54

Dean Jacoby is now president of his own company, Prisma International Inc., operating out of Concord, Mass. Despite the demands of establishing his own business, he finds time to keep us informed of the activities of other members of the class, especially those whose exploits make national news. He calls our attention to an article in the July 30 issue of *Businessweek,* concerning Walter Mondale's chief economic counselors. The article features **George Perry,** complete with a picture of George and his pipe. George is with the Brookings Institute and, according to *Businessweek,* might well become chairman of the Council of Economic Advisers in a Mondale administration. (By the time you read this, of course, we all will know whether Mondale has an administration.) On a different front, Dean sends along a page from a recent issue of *Squash News,* which reports that **Colee Bresee** won the Men's D title in the Northern California Squash Racquet Championships. Dean claims part of the title, saying that he taught Colee to play the game a year or so ago.

Dominick Sama, class vintner, has been promoted to full professor in the College of Engineering at the University of Lowell in Massachusetts. Dominick's specialty is plastics engineering. . . . **Bill Browder,** who is professor of mathematics at Princeton University, was elected to the American Academy of Arts and Sciences last May, joining a distinguished group of some 2,300 who conduct programs of study and publication on issues of national and international impor-

tance. . . . **Jim Hazard** reports that he is still at Scott Paper Co. in Philadelphia, designing machinery and instruments. Jim lives in Swarthmore, Pa. with his wife Ann and their children. He reports that three of the younger Hazards have completed college and are gainfully employed. One is a junior at Swarthmore College, and the youngest is still in high school.

Barbara Black, class vice-president, has gone back to school. She is finishing her Ph.D. in mineral economics at Pennsylvania State University. . . . **Bob Evans,** class treasurer, is professor of economics at Brandeis University. He has just become chairman of the department (again), and has been elected (again) to the Acton and Acton-Boxborough Regional School Committees, in Massachusetts. Bob spent the 1982-83 academic year in Tokyo, teaching at Keio University on a Fulbright grant. More recently, he was in Hawaii participating in a conference on Japanese and American educational systems. He and his wife Lois live in Acton, Mass. . . . **Bob Warshawer,** permanent class reunion chairman, is the manager of planning and scheduling for the strategic systems division of GTE Products Corp. in Westborough, Mass.—at least, that is what he says he is, although he seems to spend most of his time organizing our reunions.

Please let us know what your are doing these days. Our supply of class news is running out.—**Edwin G. Eigel, Jr.,** Secretary, 33 Pepperbush Ln., Fairfield, CT 06430; **Joseph P. Blake, Jr.,** Assitant Secretary, 74 Lawrence Rd., Medford, MA 02155

55 30th Reunion

Your 30th reunion is coming up. That's a long way from those morning runs through the corridors when you were a freshman (freshperson). I don't want to say we're old, but half the world today wasn't born when we graduated.

The class of '55 is going to have a great 30th reunion. Under the inspired leadership of **Pete Toohy** and **Glenn Jackson,** we are on our way. You have received the first notice; in case you didn't, I shall summarize. This reunion will begin at M.I.T., then move to the Harbor View Hotel on Martha's; Vineyard. The dates are June 6-9, 1985. There will be festivities and occasions of delight, and you will have a good time. Plan to attend; be sure to send a reply to the mailing. And by the way, put in a check for class dues. As an added incentive, there will be a drawing for a free reunion package of events. The winning name will be drawn from those who send in their reply, including class dues, before December 1, 1984, excluding the reunion committee.

And if you could find it in your heart to send a news item to your class secretaries, it would lift them out of their depression, and help to air out their mailboxes. Add a note to your reply to the reunion notice; at our age, notoriety helps.—Co-Secretaries: **Marc S. Gross,** Winding Road Farm, Ardsley, NY 10502; **Allan C. Schell,** 21 Wedgemere Ave., Winchester, MA 01890

56

By the time I read these notes in the *Review,* our trip to Spain will seem a lovely dream. Russell and I (Caroline) visited our daughter and spent a delightful three weeks seeing many cities with their lovely cathedrals, palaces, and mosques. It would be hard to decide which was our favorite.

Among the sparse notes we have received is one on **Andrew J. Viterbi,** who has been president and chief executive officer M/A Com-Linkabit Corp. and is at present chief scientist and senior vice-president of the parent company.

From Saratoga Springs, N.Y. comes news of the election of **Paul H. L. Walter,** professor of chemistry at Skidmore College, to a two-year term as president of the American Association of University Professors. After graduating from M.I.T. Walter earned his doctoral degree at the University of Kansas. He began his career as a research scientist with DuPont's central research department and served as a visiting scientist at the University of Stuttgart 1964-65. Walter joined the Skidmore College faculty in 1967 as an assistant professor. Since 1975, he has chaired the college's Department of Chemistry and Physics. In his new position Walter said that his "first goal" is to defend the AAUP's statements of principle. He also would like to see the AAUP become more involved with the problems of traditionally black colleges. Walter has been involved with the AAUP since 1967 and has held various offices on a local and a national level.—Co-Secretaries, **Caroline D. Chihoski,** 2116 W. Davies Ave., Littleton, CO 80120, (303)794-5818; **Robert Kaiser,** 12 Glengarry, Winchester, MA 01890, (617)729-4345

57

Richard K. Yamamoto is working with high energy particle physics and the search for Tau neutrino at Fermilab. Dr. Yamamoto is a member of the M.I.T. Department of Physics and the Laboratory for Nuclear Science. . . . **Stanley Kroder** writes from Dallas, Tex., that he celebrated his 25th anniversary with Sandy in June and with IBM in July. Stan is managing a department whose function is training computer personnel dealing with operation and TP networks. . . . **Alan Budreau** has joined Sanders Associates, Inc., as the independent research and development coordinator for the Microwave Division. His previous 16 years were spent carrying out acoustic research at the Rome Air Development Center Electromagnetic Sciences Division at Hanscom Air Force Base, Mass. His article, "Acoustic Variable Time Delay," was published in the April 1984 issue of *The Reflector.*

James J. Wenskus, development engineer, Eastman Kodak Co., has been named one of the first six fellows of the Society of Plastics Engineers. . . . **David Colling,** College of Engineering, University of Lowell, was promoted to associate professor. Professor Colling is a registered professional engineer and specializes in industrial technology at University of Lowell. . . . **Julian H. Cherubini** is president of AhMed, Inc., Boston, which provides health care aids to the disabled. A new subsidiary has been formed, Positecna, which deals in x-ray (medical) accessories. . . . Happy holiday season and best wishes for the new year.—**Vivian Warren,** Secretary, 156 Northrop Rd., Woodbridge, CT 06525

60 25th Reunion

The countdown to our 25th reunion continues! Just over six months to go! Be with us in Cambridge on June 6 and 7, 1985, and bring family, friends, pictures, memories! **H. Larry Elman** will be there. Says he, "Joan and I are living in the Forestwood section of Smithtown, a bedroom community on Long Island's north shore, just aboult halfway out on the island. She is still teaching flute and performing locally. I am running a small section of Fairchild-Republic. My section is in the Operations Analysis Organization, and is devoted to both military and commercial applications for our aircraft (1-10, SF-340, and T-46 primarily). A few weeks ago I was selected for full colonel in the Air Force Reserve. My assignment is with Air Staff in the Pentagon, where for the past two years I have been the MA in the International Office of Air Force R&D. I am still on the research staff of the New England Air Museum (formerly Bradley Air Museum), and I still write for them. I am also working on book about the Delta winged products of Convair (F-102, F-106, B-58, F2Y, etc.). If any Tech readers out there can assist with photos, anecdotes, etc., PLEASE SEND!! See you all in Boston next year!" The Elmans have two children, David (8) and Elizabeth (11). . . . **Linda Greiner Sprague** will be there. And she may get the prize for coming the farthest! Linda is now in Switzerland for a year and would welcome visitors. She can be contacted at IMEDE, 1007 Lausanne (Switzerland) CH.DR BELLERIVE 23, phone (021) 26 71 12.

Robert C. Sprich says, "I recently returned (along with **Sue Schur**) to the M.I.T. campus to talk with current members of the yearbook staff about my work on *Technique 1960.* (Sue and I were general manager and editor-in-chief respectively.) The occasion was a proposed *Technology Review* article in honor of the 100th edition of the yearbook. I continue to live in Waban and teach literature and film at Bentley College." . . . **Christopher P. Witze** has been named president and chief operating officer of Metro Mobile CTS, a leading independent cellular mobile radio company. Chris was vice-president and general manager of American Telephone and Telegraph Co.'s Advanced Mobile Phone Service, Inc., which installed the nation's first commercial cellular mobile radio system in October 1983 in Chicago. . . . **Herbert M. Shanzer** writes that he is vice-president and general manager of Desktop Computer Division of Data General, Westboro, Mass. He joined them in November 1983, moving back to Massachusetts after spending a little over one year in Lubbock, Tex. with the consumer group of Texas Instruments.

James T. Cobb, Jr., says "I am director of the Energy Resources Program at the University of Pittsburgh. The program is now a portion of the Mining and Energy Resources Division of which I am associate director." . . . **Gerald J. Hornik** adds, "I was recently promoted to group manager, Small Business Systems Engineering, at Digital Equipment Corp., Merrimack, N.H." . . . **Larry D. Brock,** says, "My son David is graduating this year in Course II. He plans to continue in graduate school with interest in robotics and prosthetics."

Two of our classmates will regrettably be unable to be at our reunion. **Harold Levy** of Belmont, Mass. died suddenly on March 25, 1984. He was employed at Applicon, Inc. of Burlington, Mass. as manager of graphic system software. He is survived by his wife Laurie and two children. . . . **Leonard D. Spar,** Course XV, died July 17, 1984 from cancer in Novato, Calif. He was president of Survey Tabulation Services in Cambridge, Mass. and had recently moved to California. His wife Judith wrote that Leonard had asked to be remembered in the class notes. To both their families, we extend our sincere sympathies.

Right now, mark the reunion dates on the calender and drop me a line telling what you've been doing and whom you hope to see at the reunion!—**Noel S. Bartlett,** Secretary, 15320 Edolyn Ave., Cleveland, OH 44111

61

A sad note to start this month's column. **Leonard Spar** died of cancer last July in Novato, Calif. He was president of Survey Tabulation Services, Inc., a company he started ten years ago. Leonard had three sons—Steven, Daniel, and Gerald—from his first marriage. We send our sympathies to his family. . . . **Ed Sonn** sent us a long letter in which he said, "I recently marked my 12th year with National Semiconductor Datachecker/DTS. As vice-president for product marketing, I have been very active in new product development and have been traveling a lot including 15 trips to Japan in the last 30 months. Thanks to Pan Am's world pass program, Maybeth accompanied me on two trips to the Far East and the entire family spent last Christmas and New Year's Day on safari in Kenya.

"Maybeth and I were feted at a surprise party for 50 people arranged by our children to celebrate our 20th wedding anniversary last October. Paul, our oldest son, will go to Dartmouth this fall. I am looking forward to seeing you at our 25th in June 1986." Thanks for the letter, Ed.

Speaking of the reunion I got a note from the

"We have the same interests," says John Reed, '64 (left), referring to his sister, Lisa Alther, "what the South is, what Southerners talk about." Reed, who has taught sociology at the University of North Carolina at Chapel Hill since 1969, writes sociology, while his sister writes novels. In their writing Reed and Alther discuss group identity. America is made up of minority groups, and southern identity is an important topic, Alther points out. (Photo: **Burlington** *Free Press)*

alumni office that **Ira Jaffe** will be heading up our reunion gift committee. . . . Finally I see that **Richard Meehan**'s new book, *The Atom and the Fault: Experts, Earthquakes, and Nuclear Power*, published by the M.I.T. Press is out. The book discusses the issues arising from the siting of the Vallecitos, Calif. nuclear test reactor. Since "experts" were divided as to the safety of its location, Dick can look at the role of expert opinion, lay public involvement, and corporate pressures on government decisions.—**Andrew Braun,** Secretary, 464 Heath St., Chestnut Hill, MA 02167

63

A major growth industry in the United States is . . . incarceration. More in a moment; first our only news item. . . . **Vernon Bremberg** and his wife were expecting their fourth child in August. (What eventually happened, Vernon?) They already have Andrew (5), Maria (3), and Peter (1). Having lived in Manhattan, they recently moved to Summit, N.J. (66 Prospect St., 07901). That we old folks are still able to have kids is comforting.

Right now the United States has about one-and-a-half million people locked up, waiting for trials or serving sentences. That's one of about every 155 men, women, and children. (By comparison, this country—the most over-lawyered in the world—has only about one lawyer for every 400 people.) I have been told California has a five-year plan to spend $1.5 billion (not a misprint) for new prison space—just for capital expense, not operation. And this is at a time when major crime is going down—probably because the fraction of the population in the aggressive 15-25 age range is decreasing.

Unlike commerce and medicine, prisons are no places for high technology. The more you rely on technological security, the less secure you are: a guy locked up for 20 years or life has nothing else to think about but how to break out. Some of them will, no matter how good the security is. The best system is lots of guards watching. (Of course, this need for guards solves a serious economic problem: what to do with the excess history and sociology graduates.)

Before getting locked up, these prisoners, of course cause much damage to people and property. Can anything be done? (Warning: propaganda follows.) Yes: send in the clowns.

Studies show the serious criminals locked up mostly have little education, in fact are barely literate. Some lack intelligence, but most could have learned if they had had incentive. Teachers try hard to reach kids, and school boards spend fortunes. The problem is that elementary and high schools were apparently modelled on Puritan churches. ("Young man, you are here to *learn*, not to have fun.") For kids, bright or dim, this does not work—it is based on an artificial distinction. We would have less chronic unemployment, fewer career criminals, and a more joyful society if schools were allowed to be fun instead of boring.

If reading this hortatory stuff irritates you, just fill up my mailbag. And don't forget to send in your comments on whether you want your son or daughter to go to Tech.—**Phil Marcus,** Secretary, 2617 Guilford Ave., Baltimore, MD 21218

64

Summertime has just about wound down in New England. All of the pre-season sales at the ski shops are in full swing and the students have started flocking back to Kenmore Square. It's almost time to head into Cambridge to watch the U-Haul trucks get caught under the bridge on Memorial Drive at Massachusetts Ave.

First off, a brief report on our 20th reunion. Approximately 115 members of the Class of '64, spouses, and guests participated. In addition to partaking of the general alumni weekend activities, our special events included a Saturday picnic on Thompson's Island in Boston Harbor, an evening dinner dance at the Museum of Science, and a Sunday morning brunch. Also, there was a children's program, various tours, and our Class of '64 T-shirt. A good time was had by all.

Part of the festivities included election of officers for the next five years. Our new class president is **Carl Uhrmacher,** who moved up from vice-president to take over the position previously held by **Dave Saul**. The new vice-president is **Don Silversmith. Bruce Strauss** and **Steve Glassman** are repeating as treasurer and class agent, respectively. **Bob Popadic,** who had been a vice-president, is now the 25th year gift chairman. Finally, as reported last issue, yours truly replaced **Steve Schlosser** as class secretary. Many thanks to Dave, Carol, Bruce, Steve, Bob and Steve for time and effort well spent.

On to news items. **Pat Gage** writes from Montclair, N.J. that he received a promotion in 1983. He is now vice-president and director of biological research and development with Hoffman-La-Roche, Inc. in Nutley, N.J. . . . From the **Norwell** (Mass.) *Mariner* comes news that **Stephen Kraysler** has been elected executive vice-president and a member of the board of the Hanseco Insurance Co. in Boston. Hanseco is the property-casualty subsidiary of the John Hancock Mutual Life Insurance Co. (Yes, the "weather light" still shines atop their building in Boston.) Stephen joined John Hancock in 1964 and has held various actuarial and executive positions since then. He and his wife, Edith, have two children, Coreen and Kathryn. . . . A classmate is a new member of the M.I.T. Council for the Arts. **Andrew Silver** is now a film producer, director, and writer in part-

nership with his wife Yung Hee, a Wellesley graduate and a filmmaker. He taught film analysis at Brandeis and after serving an apprenticeship with director Arthur Penn, made his first film, *Next Door*, which won a Blue Ribbon Award at the 1975 American Film Festival. He and Yung Hee are in the process of putting together a series of documentaries on major living photographers for PBS.

There are just a few items left in the mailbag so please send news of your activities. The address below is my shiny new condo; I need help filling the mailbox. Thanks.—**Joe Kasper,** 1100 Salem St., No. 103, Lynnfield, MA 01940

65 20th Reunion

This seems to be a column for news from the denizens of the computer industry. **Dick Freedman** finally wrote to me directly since his notes on Alumni Fund envelopes didn't seem to get through. Dick has just left Honeywell after three years working on an 8088 operating system, and is now with Leading Edge Products, Inc., "makers of the best word processing system" he knows of. Dick says his hobbies have changed over the years. Although he still plays tournament bridge, more of his time is spent in challenge square dancing (which has more elements of puzzle solving or programming than dancing) and singing tenor in Gilbert and Sullivan operettas. Between last September and March, Dick was in *Yeoman of the Guard, H.M.S. Pinafore, Princess Ida, Pirates of Penzance,* and *Patience,* one of which was a paid engagement! . . . **Frank Deremer** writes that he and his wife Lynda have a daughter, Charis Grace, 2, and another child on the way. Frank is president of MetaWare, Inc., producer of the MetaWare Translator Writing System and Professional Pascal. . . . **Ed Burke** begins a fund envelope with a reference to our "Macy's and Gimbel's relationship." (Ed is with Data General; I am still with Digital Equipment.) Ed says that the family is doing well in North Carolina and that they have just completed a house on Cape Cod. They planned to have furniture in before the end of the summer. Ed says that his job (as director of the Data General lab at Research Triangle Park) is going well as Data General "gains market share from our traditional rivals." (He wanted me to print that part verbatim.) Ed reports that many of their new products, including all of the Unix offerings, came from RTP.

The non-computer folks also contributed a couple of notes. . . . **Charles (Chico) Gholz** writes that he is now president of the M.I.T. Club of Washington, D.C. and that he thinks their club is the second most active after Boston, though New York City might dispute that. Other than that, Chico is busy with his patent law practice. His 13-year-old son has become a computer hacker and seems well on his way to the Institute. . . . **Patric Dawe** is a principal of a new architecture and planning firm, the Community Design Group in Pasadena. Their specialty is master planning for public and private sector clients. Patric's prior experience is 15 years of architecture and planning as a private consultant.

So much for November . . . it is "really" August as I write, and I have to get ready for business trips to California and Washington, prior to a late-August vacation and business trip to England and Scotland. If there is no material for the first column of 1985, maybe I'll tell you about the sights we saw.—**Steve Lipner,** Secretary, 6 Midland Rd., Wellesley, MA 02181

67

The adage "No news is good news" is not true in this case . . . unless everyone is on vacation or having too good a time to write. I received no news this month, and that's an official record. Why not send me a postcard or short letter to let us know about events in your life?—**Jim Swanson,** Secretary, 878 Hofman Terrace, Los Altos, CA 94022

69

The spirit of June's 15th reunion lives on. **Geoffrey Russell** writes: "Linda and the boys and I had a great time at the 15th reunion this spring. It was fun to see some of the people I had lost track of over the year, especially **Tim Casady,** who's now living in Los Angeles. I was only sorry that a few more Theta Delts weren't able to get back to Boston for the reunion." . . . And apologies for not coming arrived from **Chris Ryan:** "I was sorry to miss the class reunion, but my overseas construction company just signed its first contract, in Japan. We are getting them back for a few Toyotas! So I was in Tokyo. After 16 years, I am taking up rowing again. I bought a single scull and am out on the Allegheney."

Farrel Powsner and wife Sheila are happy to announce the birth of their third child, Michael Alan, on May 31, 1983. . . . Continuing to catch up on old notes: **George Flynn** got his Ph.D. in physics at Washington University (St. Louis) in July 1982. His thesis topic was a search for superheavy elements in samples of the Allende meteorite. He is now an assistant professor of physics at Embry-Riddle Aeronautical University in Dayton Beach, Fla. . . . **David Kiang** related his travels: "After finishing S.M. in Course XVI in 1971, went to Canada (Montreal) to work in the aeronautics consulting field for two years. Then came back to Cambridge to study at Harvard Business School. Became a banker in 1975 and am now general manager of a bank in Hong Kong." Old aerospace engineers never die, they just get richer!

Mel Basan writes that he is still a lawyer with the NLRB in Chicago and was surprised to read that there is another classmate with the NLRB in Pittsburgh—small world. Mel spent a week at an archeological site digging up 1,000-year-old Indian remains along the Illinois River and had a great time. . . . **David Breindel** is now a psychiatrist in private practice in New York's Westchester and Bronx. He is married to Lynn, an accountant, who keeps him "well balanced." . . . **Daniel Benn** is married, with two children, and operates a software company in Montreal. . . . **Jim Black** has three children and a 3-year-old business, VideoStar Connections, which provides satellite delivered video conferencing services for corporations, hotels, universities, and associations nationwide. . . . **William Buote** had a career as a naval architect and one in commercial data processing. Now he works at Zymark Corp. in Hopkinton, Mass., where he is vice-president of R&D. Zymark manufactures laboratory robots and automation systems, principally for analytical chemistry and biotechnology. He and his wife, Patty, have three children, 14, 11, and 8.

Stephen Osheroff now lives in Austin, Tex.—"the computer technology growth center of the near and far future." He has been a consultant to small businesses in the use of integration of microprocessors with routine business activities. Getting away from high tech (but not completely), **V. Chuck Howey** manages a potato grain farm in southern Colorado and owns a computer store in nearby Monte Vista, Colo. . . . **Walt Maurer** is presently in the practice of internal medicine and critical care in Marshall, Mich. He has two children, 4 and 6. . . . **Frank Guillot** writes from Burlington, Vt., "My wife, Ann (clinical professor of pediatrics at the University of Vermont Medical School), and I are kept busy by our son John, 6, and daughter Mary, 2 1/2. I still have my own architectural firm and am branching out into various development projects including housing, a microbrewery, and a sculling boat company."

Eben Walker and his wife, Patty Brooks, have moved from New York City where they lived for seven years to Greenwich, Conn. He has gone to work for his father's bearing manufacturing company in Yonkers, N.Y., which he describes as "not high tech, but lots of fun." . . . **W. David Lee** became manager of engineering science at Arthur D. Little, Inc. His second child was born this year, and he reports that he still rows on the Charles River. . . . **Henry H. Fuller, Jr.,** also involved with boats, is now forming the National Steam Propulsion Co. to build coal powered locomotives and towboats.—**Eugune Mallove,** Secretary, 215 Highland St., Holliston, MA 01746

70 15th Reunion

Lee K. Fox recently spoke at the biennnial forum on behalf of Arthur D. Little, Inc. where he is involved in industrial congeneration, the simultaneous production of useful power and heat. . . . Also speaking at the biennial forum was **David W. McComb,** who spoke on the topic of improving quality and productivity as a competitive response in the market place. . . . **W. Alan Stiehl** is a senior engineer at Polaroid Corp. in Cambridge. He indicates that his son, Danny, is very interested in computers.

I received letters from several classmates. **Julie (Mazel) Sussman** of Arlington, Mass. has co-authored a book with her spouse, Gerald ('68) and Harold Abeleson, Ph.D.'73. The textbook is used for M.I.T.'s introductory computer science course. It is the first book in the M.I.T. Electrical Engineering and Computer Science series. . . . Also received a letter from **Steven Cooper,** who lives with his spouse, Marilyn, in Sherman Oaks, Calif. He indicates that a previous column was numerically incorrect, i.e. he has one wife, one son, one dog, and three cats (not three children). Having tried to explain this to his spouse and friends without much success, he decided that he had better write me with the accurate information. Unfortunately, some letters get generated to clarify previous errors in columns, however I hope most material is accurate.—**Robert O. Vegeler,** Secretary, Dumas, Backs, Salin, and Vegeler, 2120 Ft. Wayne Natl. Bk. Bldg., Fort Wayne, IN 46802

71

Congratulations to **Gary H. Lantner,** who was named vice-president and secretary of Republic Airlines and is responsible for the airline's legal department, properties and facilities, corporate design, and shareholder relations. Gary was formerly with Continental Airlines as senior director of aircraft programs.—**Hal Moorman,** Secretary, P.O. Box 1808, Brenham, TX 77833

72

Just one letter this month, from **Edward Rich:** "I was recently promoted from the legal department to manager, leasing of Dow Chemical U.S.A. I am now responsible for all tax-leveraged leasing for Dow in the U.S., and I manage a group of people in this Dow treasury department function. My wife, Ann, and I have a 1-year-old daughter, Ashley, and we all enjoy living here in Midland, Mich."

As they say on the billboards, "This space available. Put your message here." Write Wendy or me.—**Dick Fletcher,** Secretary, 135 West St., Braintree, MA 02184

73

Larry Esposito is now an associate professor in the Department of Astrophysical, Planetary, and Atmospheric Sciences at the University of Colorado, Boulder. Larry is working on preparing for Voyager trips to Uranus and for UV observations of Halley's comet from a Venus orbit.

An 11th mini-reunion was held in St. Louis on Memorial Day for several former McCormick resi-

dents at the home of **Irv** and **Jean Paskowitz,** who are both with Monsanto in St. Louis. Much of their time though is taken up with Dan (9), Mike (7), and Tom (5). Also present were **Ellen Reintjes** and **Don Tatzin** from Layfette, Calif. They were married in 1982, after which Don is now a consultant with Arthur D. Little, and Ellen a senior financial planner with Golden West Financial.

You want to know what's new with us? Write!—**Robert M.O. Sutton, Sr.,** Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

74

As I write these notes in late August, it's easy to get into the right mood for the November-December column. Tonight it feels like November because the temperatures in and around Boston are in the 40s! Memories of our 10th reunion still linger in my mind. If any of you are still waiting for reunion T-shirts, please contact me now because I believe I have filled all the post-reunion orders. If any of you still want T-shirts (these will be hot items 10 years from now!), please contact any class officer or drop me a line. I'll write back and tell you what is left.

At our 10th reunion this past summer, **Mary Ann McCarthy** and **Rich Sternberg** became members of the Class Secretary Movement and are now assisting Lionel and myself and the other class officers with the duties of collecting, recording, and disseminating information to the class. We certainly need the help, and we welcome them to their new positions. For those of you who feel inclined to write to us, please let us know your thoughts concerning the 10th reunion (even if you didn't or couldn't attend).

I received the following letter at the reunion: "This is the first write-in since graduation from **Marc Belfer,** who is now known as **Marc Goldring**. Received Ph.D. in physics in 1982 from Brandeis University, where I studied the electrical response of a cell of the retina to a single photon! Fascinating! Since receiving the degree, I have continued these studies at the postdoctoral level, and have also taught introductory computer at Brandeis. In the fall, I'll start a new venture at AT&T Bell Laboratories in Murray Hill, N.J. with their business analysis group—lots of mathematics there, which I love at least as much as ever, thanks in large part to the M.I.T. physics department—Yay! I plan to travel in Israel and Europe this summer. I am still single, but definitely not by policy. Any takers? Our 10th reunion was beautiful-thanks!" Marc, I hope things are going well in Murray Hill. Write sometime and let us know.

Catherine Mink sends a few notes about her activities. Here is the impressive and hectic list: computer graphics, the biology of striped skunks, gardening, house renovation, and wine—and not necessarily in that order! . . . **Ed Arippol** writes from Milan, Italy, where he has been living for the past two years. He has been working for the family business which is in importing/exporting fruits and vegetables. . . . A news flash from the Mayo Clinic in Rochester, Minn. says that **Hugh Gordon Deen, Jr.** has completed his graduate training in neurosurgery. He is now with the U.S. Navy Medical Corps in San Diego, Calif. It seems to me that it wasn't too long ago that Hugh was performing intimate surgical techniques prior to serving dinner at his Burton House digs. Congratulations, Hugh!

And now for the rumor mill. **Henry A. Magno, Jr.** (alias land baron of Cambridgeport) has acquired another three-decker with a very coveted view of MacGregor House and most of the West Campus. Henry can be seen in Cambridge "tooling" around in his latest restoration project, which is a dark brown Mercedes sedan, an early 1950s vintage. Ask him for a ride. . . . **Sandra G. Yulke,** class president has recently moved back to Arlington almost next door to **Jay Krone**. There may be a party in the works! . . . **John P. Tierney** and his wife Kathleen are the proud parents of Brian Tierney, who was born on July 23, 1984. John is now holding down two jobs: daddy and a paying position with the firm of Tillinghast, Nelson, and Warren. Kathy is busy holding down John. . . . Dr. **Jeffrey T. Mayne** is about to be married (as of this writing) to Katherine S. Mixter on September 15, 1984 in Oakland, Calif. I sincerely wish that I could be there. To Jeff and Kath: the very best wishes from all of the MacG turkeys! We hope to see you both whenever you can get here.

To the class: this is the time of year when things get very hectic and sometimes depressing! Remember to just sit back now and then and think of your friends, wherever they are. Relax a little . . . we've all still got a long way to go.—**Jim Gokhale,** 45 Hillcrest St., Arlington, MA 02174; **Lionel Goulet,** 21 Melville Ave., Dorchester, MA 02134

76

The mails have been particularly sparse, and, alas, what has come has not been entirely good news. . . . Your secretary is deeply, deeply sorrowed to report the death of **Dan DuBoff** on July 14, 1983. The news of it has just reached me. Your secretary got to know Dan during the summer of 1975, when he was living in Cambridgeport. He was a large, extroverted man with a memorable sense of humor. Our sympathies go to his parents.

David Kleinschmidt was a speaker at the Arthur D. Little Decision Resources Biennial Forum in June. His discussion focused on technologies for using energy more efficiently in such traditional, high energy consumption industries as chemicals, metals, petroleum refining, paper pulp, etc. David's specialty is industrial energy management. . . . **Erland van Lidth de Jeude** appeared in an airline commercial during the summer Olympics. It is fun to see a classmate and friend on TV. I had bumped into him on the upper west side of Manhattan, where he advised me of his upcoming appearance. . . . *Correction*: **Dan Dershowitz** and Debbi Gross' son's name is Michael Samuel.

Rita and I are finding that settling a real estate transaction is far, far more cumbersome than futures trading. Delays in paperwork have caused us to push forward our closing date and move to Forest Hills. As for the futures markets, the foreign exchange markets have been making hamburger out of people. Bonds have convulsed, and coffee and cocoa, are on fire. Supply shortages have soared. Even relatively quiet sugar was bid limit up today while I was preparing these notes. This is definitely not an economic activity for the nervous. Your secretary remains, of course, a battle-tested and hardened trader.—**Arthur J. Carp,** Secretary, 211 W 79th St., Apt. 5, New York, NY 10024 (212)362-2450

77

We start off this month with a note from **Deborah Hoover Dobson,** who is still with the subsea systems section of Exxon production research. Deborah says, "Our two sons are growing fast—the oldest enters kindergarten in September." . . . **Dorothy Zimmerman** received the doctor of osteopathy degree from the University of New England College of Osteopathic Medicine, and will serve her internship at Huntington General Hospital in Boston.

Steven Weissburg sent his first letter to *Technology Review* this month. He teases that he has recovered from his experience "as a tenant of the noted slumlord, **Phil Belanger,** to wax obnoxious on the virtues of European travel." Last fall, Steven dropped his job as a lawyer, and spent four months touring by bicycle from Paris to Paris by way of Bretagne, Baynols-sur-Ceye, Wengen, Marseille, Salzburg, Vienna, Budapest, Ljubljana, Amsterdam, and London. (Sounds neat, Steven!) Since May, Steven has been with the Boston patent law firm of Kenway and Jenney, and is enjoying it. He has seen many classmates, but will not comment on any others, "in the hope of avoiding a few libel suits."

That is all for this month. Please write!—**Barbara Wilson Crane,** Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

79

Greetings, classmates. Here's the roving reporter to continue the saga of our fifth-year reunion. The activities started on Thursday, June 7, with Tech Night at the Pops. Friday, June 8, was Technology Day. The roving reporter showed up on Friday night, in time for the roller skating and pizza party with the class of '74 at the new athletic center. The athletic center is pretty spiffy. Bel Canto pizza, Toscanini's ice cream and a lot of good company made this event a real treat.

On Saturday, the class rented a bus and took off for Endicott House. I'm afraid that I can't report on this event, as I spent the afternoon at the Museum of Fine Arts, but I understand that the swimming pool was pretty popular. (Those of you here on the East Coast may recall that it was close to 100 degrees all weekend.) There was no organized activity that evening, so I finally got to eat at Joyce Chen's in Fresh Pond (I guess I didn't have enough friends with cars when I was an undergrad!) On Sunday morning, we had a brunch at the Hyatt Regency, where we elected the new class officers.

By the way, there are still class shirts and directories left, if any of you are interested. The shirts are all white, with a collar and three buttons at the top, and are of a polyester-cotton blend. On the front, there is a brown drawing of a class of '79 brass rat and the words "Class of '79 5th Reunion." I've got one, and they launder just great. The shirts are $10 each. The directories list all class members with addresses and places of employment. They are $5 each. If you are interested in a shirt or directory, send me a check. Please include shirt size.

Here's some gossip provided by those class members that attended the reunion. **Helen Chihoski** is living and working in Spain. . . . **Elaine Sears** has finished her first year at Harvard Business School. . . . **Laura Rees** and husband **Bob Willett** are back in the Boston area after having both finished medical school at University of California at San Francisco. Laura is doing her residency at one of the Boston hospitals, while Bob is getting his Ph.D. at M.I.T. . . . **Russ Steinweg** is working in California. . . . **Marc Levine** got his master's in computer science from Stanford in 1980. He's now working for Teradyne in Boston and has been married for five years to Nina, a special education teacher. Daughter Jessica is almost 2 years old. The Levines own a house in Lexington.

Monica (Williams) Harris graduated Tufts Medical School in June 1984 and is now doing her internship in internal medicine at Mt. Zion Hospital in San Francisco. In 1981, she married Nicholas Harris, a Course IV grad student at M.I.T. They have a 2-year-old daughter, Rebecca. . . . **Gregg Stave** is finishing the M.D./J.D. program at Duke University. He recently got his J.D. and passed the bar exam. In December of this year he will finish medical school and will begin an internship in internal medicine. . . . **David Gibson** got out of the army on June 5 of this year, and left Germany with wife Linda. They are now living in New Jersey, along with their son, who was born last December. David was planning to start at the Sloan School in September. . . . **John Fratamico** owns a house in San Diego.

Jerry Marks is a senior instructor for G.E. in San Jose, teaching future reactor operators. . . . **James Fujimoto** got his Ph.D. in electrical engineering from M.I.T. in June 1984. . . . **Marcia**

Steve Segarra, '84, leans against a Model T Ford at the American Precision Museum in Windsor, Vt., where he worked last summer as a **Yankee Magazine** *intern. The car was manufactured with tools displayed at the museum.*

Grabow recently finished the defense on her Ph.D. in materials science at Stanford. In September 1983, she was married (on her birthday!) to another materials Ph.D. who works for Bell Labs in New Jesey. Not surprisingly, she plans to move to the East Coast! . . . **Mimi Fuhrman** is a grad student in geology at the State University of New York at Stony Brook and will be getting her Ph.D. in 1985. In January 1984 she married a Greek who belly-danced at their wedding! . . . **I-Hwa Midey Chang** was married in 1982 to structural engineer Joaquin Mateu, who went to elementary school and high school with **Arlyn Garcia-Perez**. Midey got her Ph.D. in chemical engineering from Northwestern University in August. Starting in September, she was planning to work as a senior scientist in suburban Philadelphia.

Juan Lopez works for Exxon in Houston and owns a house nearby. . . . **David Fernandez** got his M.D. from the University of Puerto Rico in 1983, and is doing a pediatric residency there. . . . **Juan C. Fernandez** got his Ph.D. in plasma physics from Berkeley in June. In 1981, he married his high school sweetheart, Odalys. They had a baby in 1982. . . . **Jesus M. Alvarez** has left Boca Raton, Fla., with wife Rosa Marie and is now residing in Puerto Rico. . . . **Jose Luis Fernandez** got his M.D. from New York University in June of this year, and is now an intern in internal medicine at Cornell.

Joan Ludlam lives in Boston and is product manager for a major appliance distributor. She is really into windsurfing. . . . **Mark Unkrich** is living in San Francisco and working for Hewlett Packard in integrated circuit design work. . . . **Greg Wilson** and **Bill Doskocil** work for the navy in Virginia, near D.C., in naval nuclear matters. Bill has one child and another on the way. . . . **Marla Eglowstein** was at the reunion, but snuck off before she could give me any more details other than that she is living in Brooklyn Heights and is a 4th year medical student at New York University.

Your faithful secretary is taking time to type this column when she should be packing. Tomorrow it's off to Switzerland for ten days. No, I don't ski, but I love to sightsee. I've got a German pocket phrase book, a working knowledge of French, and a hearty appetite for cheese and chocolate! Hope to find a mailbox full of letters from you all when I get back.—**Sharon Lowenheim,** Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

80 5th Reunion

On April 15 **Ron Efromson** and Cathy Vanden-Heuvel were married in Boston. Among the wedding guests were best man (and ex-M.I.T. roommate) **Jamie Burnside, Chris Cole,** Katie ('83) and **Tony Parham,** Chris Eckler, '79, Joel Mattox, '79, and Larry Ames, '79. Ron and Cathy took off for St. Maarten after the wedding, and then set to work buying a house in Arlington. Jamie Burnside is now at school at Berkeley. . . . **Clif McFarland** left his Standard Oil job in San Francisco for a consulting firm in Gainsville, Fla. called CH2M-Hill, in the firm's hazardous waste management group. In between, he spent three months traveling in Greece, Israel, Egypt, and Nepal. By the way, Clif's trying to track down an ex-M.I.T. roommate. (Are you listening, Dan?)

We have several new doctors among our fold. **Diane Gorczyca** received her medical doctorate from Albany Medical College of Union University in Albany, New York. While there, she received a fellowship from the American Psychiatric Association for clinical studies. She has now begun serving an internship in primary care internal medicine at Cambridge Hospital, an affiliate of Harvard Medical School. . . . **James Karlen** recently graduated from the University of Virginia Medical School. He is now a first-year resident in surgery at Case Western University Hospitals. . . . **Marty Plys** finished up his doctorate at M.I.T. back in March, defending a thesis on "An Experimental Investigation of the Core-Concrete Interaction" (the China Syndrome). He made it back to the 'Tute in June for the grand ceremonies and is now living in Chicago near Grant Park.

Andy Chiang, a faithful *Technology Review* reader for four years now, has decided that he has been quiet long enough and it was time to write. (Everyone out there hear that wise philosophy?) Coming out of M.I.T., Andy did some consulting with banks in New York City on fault-tolerant software systems. About a year ago, he started his own firm, doing system architecture consulting and producing graphics software. Another activity that has been occupying Andy's time is a new Chinese Alumni of New York Club that he and 11 other M.I.T. alumni started in the New York metropolitan area. The club has immediately snowballed, attracting about 60 members in the first three months and starting a distinguished lecture program. Anyone interested should contact Andy at 201 East 21 Street, 14M, New York, NY 10010. (OK, the plug's in, Andy. Where's my bribe?)

Basil Safos writes that he is now a money manager at the Bank of New York, and still avidly enjoying hunting for loaches. . . . **Namir Kassim** is working on his Ph.D. thesis at the University of Maryland's Clark Lake Radio Observatory. The thesis involves work "on a low frequency high resolution survey of the galactic plane region." (I don't profess to know what this means, but it certainly sounds impressive, Namir!) . . . **Michael Sider** is vice-president of IFA Systems, Inc., a New York-based company specializing in information systems for companies in apparel, textile, and retail businesses. He is also completing an M.B.A. at New York University. Michael's wife, Gail, was recently admitted to the New York State Bar and is working as a labor arbitrator.

Robert Cosway, an associate actuary for Milliman and Roberston in Seattle, Wash., was recently selected for membership in the American Academy of Actuaries. . . . **Robert Humphries** was married to Kimberly Heefner on June 16 in Rose Haven, Md. **Ed Gillett** did duties as an usher. . . . **Timothy Harrigan** has been named an M.I.T. Whitaker Health Sciences Fund Fellow for 1984-85. The Whitaker Fellowship program supports graduate students conducting doctoral research in the biomedical sciences and engineering. Tim's work, in the Department of Mechanical Engineering, is "modelling the human hip joint to assess lubrication mechanisms and thus identify mechanical factors in osteoarthritis."

Jim Phelps wrote in from a freezing rain in the middle of July in Brooks Range in Alaska. This is the second of three summers Jim is spending "looking at rocks." It is part of a program at Rice University in Houston which will culminate with an M.A. and Ph.D. in geology for Jim. Jim was married a few years ago to his high school sweetheart, Susan. He's been in Houston for almost five years now, spending the first two as a geophysicist with Exxon. . . . **Barbara Hill Thornton** wrote in and cleared up a mistake I made in my July column. She did graduate from M.I.T. with two master's degrees this June, but they were in business and architecture ("My heart has always and shall forevermore belong to architectural design."), and not in mechanical engineering, as I had previously reported. Barbi and husband Peter are now living in Beverly, Mass.

Captain **James Buckingham** has been decorated with the U.S. Army Commendation Medal in Dexheim, West Germany. James is a battalion adjunt with the 12th Engineer Battalion. . . . **First Lieutenant Robert Stone** has participated in exercise Cape North at Nyutabaru Air Base in Kyushu, Japan. Robert is a fighter pilot with the 8th Tactical Fighter Squadron at Holloman Air Force Base, N.M. . . . Army Reserve Private First Class **Randall Heath** has completed basic training at Fort Jackson, S.C. . . . Captain **Gary Smith** recently returned from a three-year tour of duty in West Germany where he served with the 596th Maintenance Co. He is currently stationed in Warren, Mich.

Curt Sanford has been sent by Bolt, Beranek, and Newman to London to open up a new office there. I'm sure that Curt will send up enumerable details of his adventures, and we will anxiously await those. . . . As for me, I am also transferring between BBN offices. I'm only a few weeks away from leaving Germany and returning to Cambridge. At this moment, I can't wait to get back to Boston. In the meantime, I am trying to stuff in a few more European jaunts. I have recently visited Jerusalem and Venice, and still have plans to go to various parts of Switzerland (for the nth time) and a first-time trip to the Scandanavian region. Until further notice, I can be written to at—**Ken Turkewitz,** Secretary, BBN, 50 Moulton St., Cambridge, MA 02238

81

Thomas Fitzgerald is working for Datapoint Corp., designing and writing software for operat-

ing systems and office automation. . . . **Douglas Smith** writes: "I've finished one year at Law School. I'm splitting the summer between the Office of General Counsel at the EPA in Washington and the Real Estate Development Center at M.I.T. Recently attended the wedding of Bill Glickman, '84, and Amy Ritzenberg, Ph.D.'84, in Williamstown, Mass. Mande the Rabbit is reported to have enjoyed the ceremony immensely." . . . **Elliott Berger** reports that his lifetime goals are coming along. He was recently promoted to senior engineer at Steinberger Corp. in Woburn, Mass., is still working (part-time) on his master's degree in electrical engineering and computer science at the 'Tute and is "still looking for a Jewish girl." Best of luck.

One note from your class secretary: if you or anyone out there wants to be reclassified by the Alumni Records office in regards to your class membership, let me know. For instance, you're just dying to receive those class of '81 mailings but only get the class of '83 stuff 'cause you graduated two years late. If this is you, please drop me a line and I'll talk to the computer about it. We'll be happy to straighten it out to suit your preference.

All right, folks, write! Go ahead, make my day.—**Chuck Markham,** Secretary, 362 Commonwealth Ave., Apt. 2E, Boston, MA 02115

82

Congratulations to **Lili Sing** who is now Lily Ablondi. In June she married Mike Ablondi, a Tufts mechanical engineering graduate who now works for G.E. in Cincinnati. Lily works for Proctor and Gamble there. . . . **David Sheppard** writes that he is working for a startup called Laser Data. He's also doing music, sound production, and graphics for his own company, Sound Visions.

Marc Rose received a master's in computer engineering from Carnegie-Mellon last year. He's now working for the computer-aided design group at Intel in Santa Clara, Calif. . . . **Bob Dewitt** was a delivery doctor at Jefferson Davis Hospital earlier this year. At last tally, he had delivered 23 babies! . . . **Jerry Fitzgerald** is working at Biogen in Cambridge. He's installing personal computers at research hospitals to gather data on interferon's clinical trials. Jerry will be going to Geneva soon to do the same in Europe.

Steve Vaughn enjoyed the summer at the Gorlon conference on lasers in medicine and biology, and the photobiology conference in Philadelphia. He also visited a few friends at the Institute and then headed back to the University of California at Irvine.

Another marriage! **Patty Robinson** is marrying Charlie Boucher. . . . **Josephine Lee** just passed her master's exam and now has an M.A. in English literature. She's teaching Shakespeare this fall. She says she hasn't done much on her thesis yet, but it will probably be on some aspect of drama, probably modern British. (Try to put that into equations!) Josephine spent last summer "hitting the five S's"—swimming, skating, studying, slaving away as a part-time researcher for the Carnegie Foundation for the Advancment of Teaching, and sleeping. (Make that six S's—add socializing!) Josephine's been in touch with classmates **Bill** and **Maria Dawson** (nee **Petrocchi**), who are living in Long Beach, Calif. Maria marked the 24th mile of the marathon at the Olympics last summer. Other Olympic watchers were Rachel Cotter, '83 (three soccer games at Stanford) and Dave Slobdin, '81 (ten nights in the bar at Princeton).

Peter Rogers completed the Air Force Institute of Technology program and received a bachelor's degree in aeronautical engineering. . . . **Eric Peyrard** is back from Maracaibo, Venezuela and is now working at the International Affairs of the French Department of Transportation. He writes that **Michele Cyna** is also at the French DOT. . . . More news on **Steve Vaughn.** (I assume it's the same Steve Vaughn. I got *two* notes from him. I'd be happy with one from the rest of you.) He's continuing his research on biochemistry of photoactivated product formation in epithelial cell lines. . . . Thanks to **Floyd Fernandez** for the postcard of the month. He's working at the Aerospace Corp. in El Secundo tackling problems in satellite attitude control. He's living at Hermosa Beach with his new wife, (I don't think he had an old wife, but anyway . . .), Kathleen Profet. **Vicki Scheer** was at the wedding. She's working at Northrop and living in Rancho Palos Verdes. Congratulations Floyd!

Mark McMillen, Bret Wallach, '81, and their former TRW supervisor have broken off from TRW to start their own company, Advanced Processing. Their main business areas include systems and software design of signal processing and data processing systems, and high performance microcoding for array processors. They're located in San Diego, (619)566-0602, and welcome any inquiries. (See, you can get free advertising just by writing to your class secretary once in a while.) . . . **Shirley Koppel** is working at General Dynamics, Fort Worth, as a test flight engineer on the F-16 fighter.

Linda Schaffir has been working for a real live architect the last two years (sure beats working for the unreal, dead ones) and has decided that it's time to follow through on "architect training procedures." So she's at the University of Pennsylvania working on her master's degree in architecture. Look her up if you're in the area. . . . Threat-of-the-month award goes to **Evan Morris.** He has volunteered to guest author a class notes column, *but* if he doesn't get enough mail to fill a few pages he will either make stories up about you, or worse, fill the column with his terrible jokes. So to prevent letting loose Evan's "humor" on the class, please send some mail to him at 2112 Lenox Rd. No. 305, Cleveland Heights, OH 44106. (P.S. Evan's engaged to Adelle Merenstein.) Or you can still send stuff to me.—**Rhonda Peck,** 38 Bigelow St., Cambridge, MA 02139

84

Column No. 3 is brought to you from solitary confinement in the Neuroendocrinology Laboratory of the Brigham and Women's Hospital in Boston. Your secretary, for some strange reason, has agreed to be the subject of a sleep study, the purpose of which is to determine how people's sleep cycles, temperature cycles, and biorhythms behave away from all time cues (e.g. clocks, TV, radio, the outside world.) As a result, I am currently confined to a small apartment (without windows, timepieces, or any other means of determining the passage of time) and allowed to eat and sleep whenever I feel the urge to do so. If this column sounds strange, please remember the circumstances under which it as written.

Even in the confines of a laboratory, my grapevine still functions; I have received news and gossip about a number of Bakerites. **John Carl Adams** (who receives my nomination for youngest-looking M.I.T. graduate) will be working for Draper. . . . **Chris Craven** has grown a beard (to prevent me from nominating him instead of Carl) and is working in the Boston area. . . . **Jeff Berner** has chosen to return to M.I.T. to play lacrosse (and for graduate study in Course XVI.) . . . **Eric Alani** will be attending graduate school in biology (I'm sure he'll write to tell me where.) . . . **Wayne Greene** is headed for California to do graduate work in chemical engineering at the University of California, Berkeley.

Oren Levine is deferring admission to M.I.T. Course II in order to work for GM for two years. . . . **Dennis Sacha** (who has actually grown some hair now that he is no longer actively Naval ROTC) will spend one more year at Tech as a Course VI-A co-op student; he's working for Draper. . . . **Mike Landmeier** will start working for Megatest in December. . . . **Vince Cotter** is gainfully employed by DEC.

A pretty, young lady by the name of Laurie Mae Tam informed me that M.I.T.'s famed wrestler, **Layne Yamada** (pronounced somewhat like the slang insult, "your mother") is still healthy, and has returned to Hawaii presumably to satisfy the demands of his many fans. Layne is known to be very popular, especially among the Hawaiian womenfolk (even haoles). In addition to his busy social life, Layne must also contend with his new job with electric power company.

Dave Alexander has decided to relocate to the most popular vacation spot of the Midwest—Warren, Ohio—where he will be employed by Packard Electric, a division of GM. People tell me that if one is not satisfied with the night life offered by Warren, one can always drive out to Detroit for entertainment. Maybe that's why Warren is so popular: the comparison will surely convince all Warren residents that it is infinitely preferable to live in Warren.

From unreliable sources, I have gathered the following gossip. **Lena Wu** is working for Arthur D. Little. . . . **Maralene Downs** is working in West Islip, N.J. . . . **Jono Goldstein** will be returning to M.I.T. as a biochemical engineering student under Dr. Daniel "Danny" Wang. . . . **Chee Seng Chow** also will return to M.I.T. to finish the fifth year of his VI-A co-op; it is rumored that he will receive bachelor's degrees in Course VI. . . . **Steve Carroll,** like so many others in our class, is enjoying himself in the San Francisco Bay area; he is employed but I neglected to find out with whom.

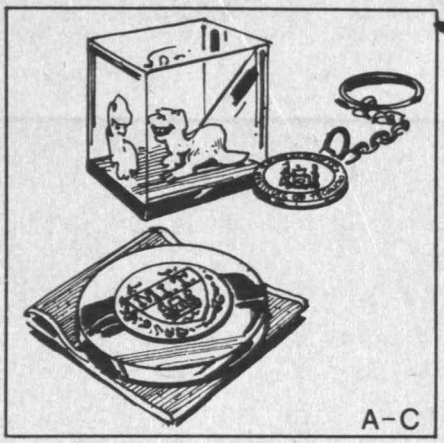
My 10.59 partner and good friend, **Don DiMasi,** spent his summer working for Merck in New Jersey and will subsequently attend graduate school in chemical engineering at the University of Michigan. Also attending the University of Michigan this fall is Mr. **Ogden Jones,** M.I.T.'s best varsity tennis player, Course XVI major from Kalamazoo. Oggie's little brother, Joe, has also informed me that Oggie is "working hard" this summer down at Cape Cod (I suspect Oggie will be very anxious to get away from the beaches and "hard work" so he can take it easy in grad school.)

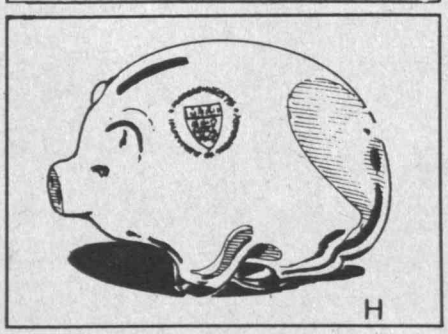
A former lab partner, **Aron Judkiewics,** is attending medical school either at the University of California at Davis or the University of California at Irvine. Another former lab partner, **Joyce Whang,** is working toward her doctorate in chemical engineering at the University of Pennsylvania. . . . Meanwhile, **Stephanie Helferrich,** yet another one of my former lab partners, will be back at M.I.T. for Chemical Engineering Practice School. . . . **Ron Rimelman,** also a former lab partner, is working for GE in Schenectady, N.Y. . . . Lastly, former lab partner **Emi Hasegawa** will be working a few years as a research assistant at the University of Tokyo in Japan.

Our class treasurer, **Lisa Tener,** writes: "Work is pretty good. I get my first project next week. The people are really nice." She further mentions: "**Nancy Beckman** and I went apartment hunting together." Nancy is working for IBM in San Jose. Lisa continues: "I also met **Terry Tatad** today. She is working for Intel this summer before she goes to Stanford. We went to some clothing factory warehouses (Esprit, etc.) and bought lots of clothes (and I haven't even gotten paid yet!)." She concludes her letter with the cryptic acronym, TTFN, which has the footnoted explanation of "Ta ta for now."

I would like to thank the staff and technicians here for so patiently tending to my every whim, and especially Dave Rios and Joe Barrocas (who delivered my columns to the *Review* office). Dave and Joe are both Harvard students; nonetheless, they are both intelligent, competent, and friendly, which goes to show that not all Harvies are bad. . . . Though it is still August for me, you are probably reading this column in December. Therefore, I wish you all a joyful holiday season and reiterate my desire to hear from you. (In other words, write!) Until next time, TTFN!—**Peter Tu,** Secretary, 410 Memorial Dr., Cambridge, MA 02139, (617) 225-8353

M.I.T. *Insignia*





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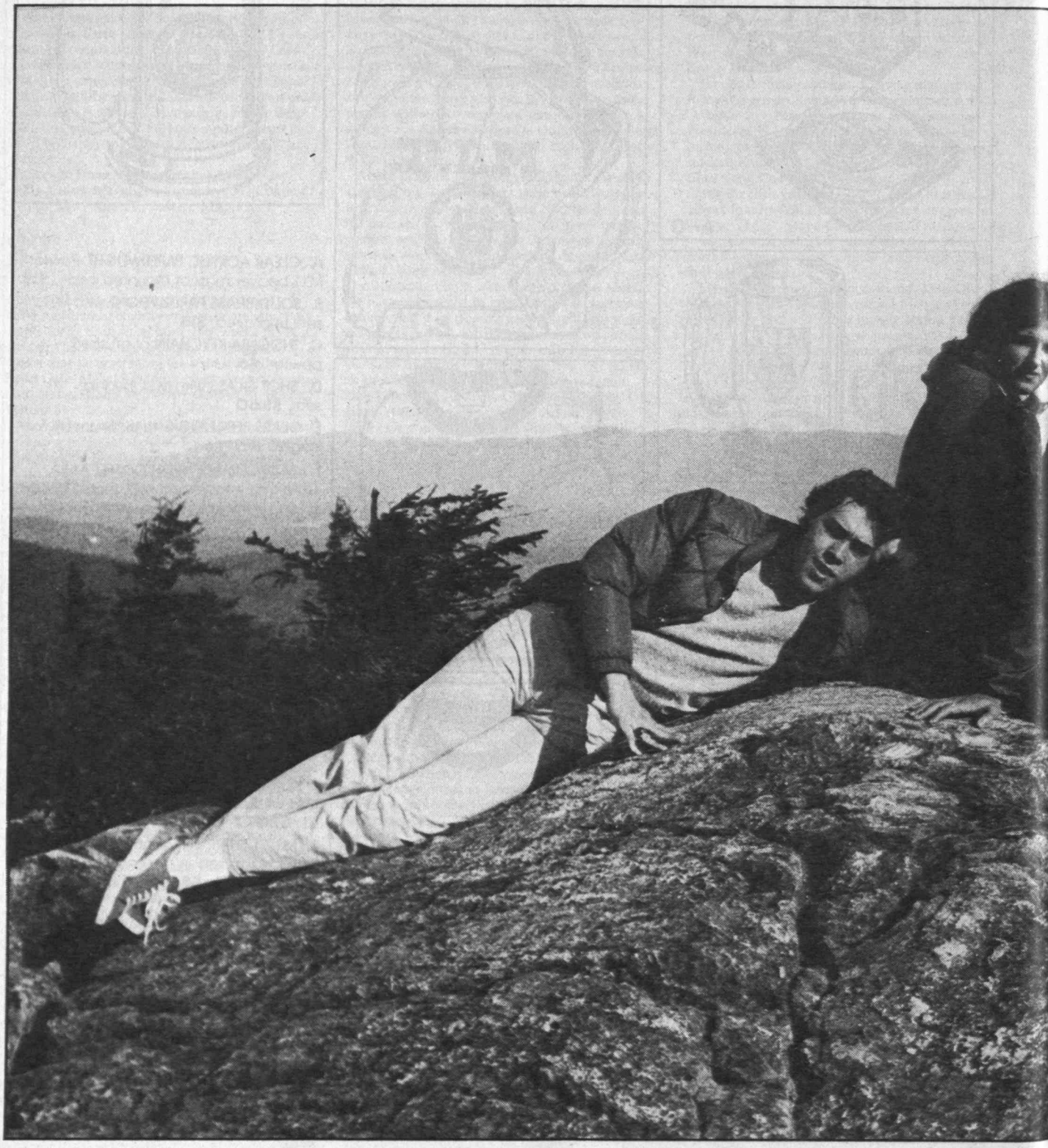
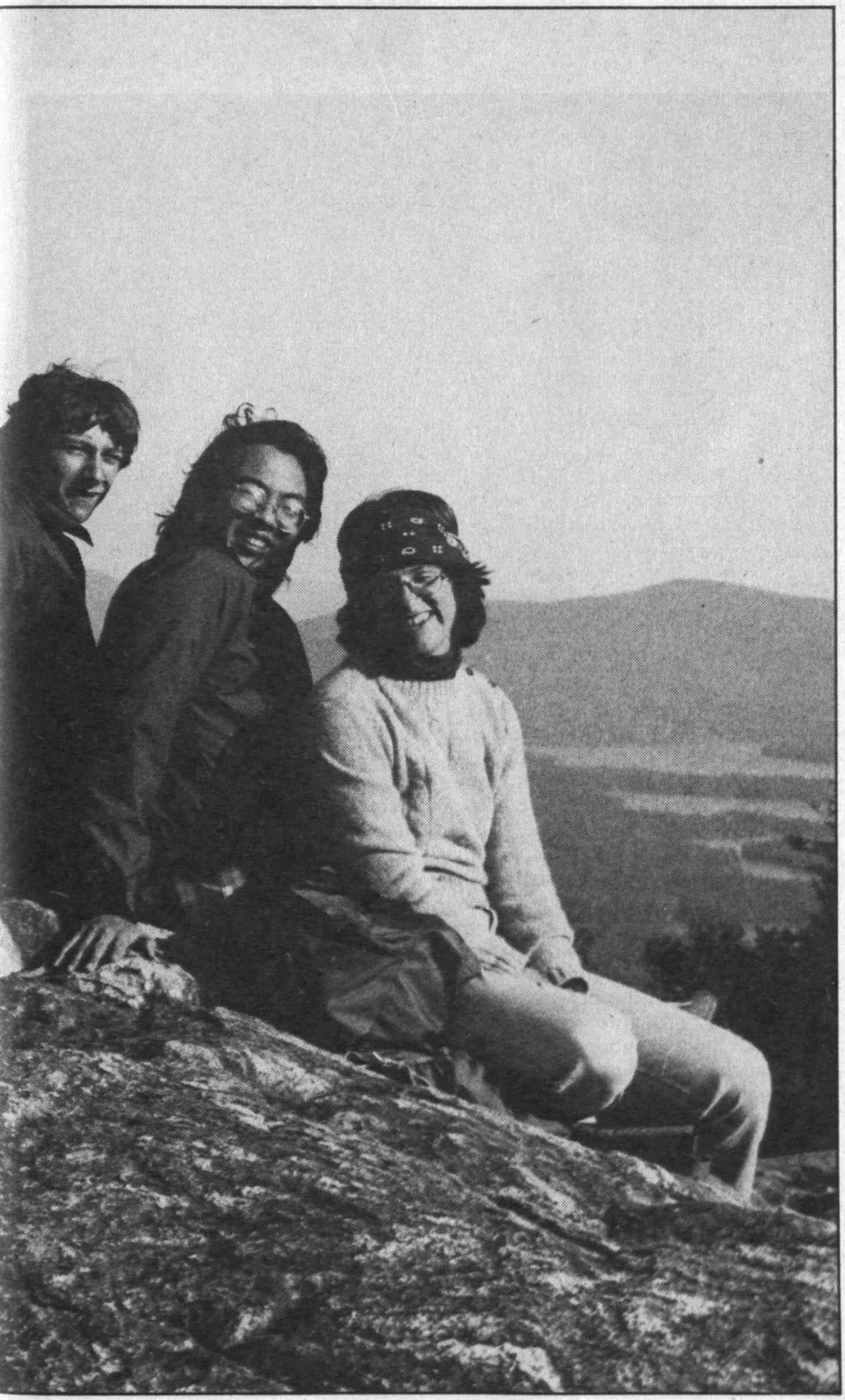
In the mid-'70s, there were spectacular role reversals between staff and students, and overachievers multiplied.



An Inside View: The Evolving Personality of ESG

BY EDUARDO OLAGUER, '80



When Professor George Valley founded the Experimental Study Group (ESG) in 1969, he wanted to give freshmen a place where they could learn on their own initiative, at their own pace, surrounded by a supportive and informal community of peers and staff members. Close interaction with faculty would allow a tailoring of education to meet individual needs. Valley's experiment worked—ESG quickly attracted a group of bright students and committed staff who formed a cohesive "family." And in the 15 years since then, ESG has been transformed from a tentative experiment in alternative education to a vital and deeply-rooted element of the M.I.T. experience.

Under the leadership of Professor Valley and his successor, Professor Robert Halfman (ESG director, 1974-1984), hundreds of M.I.T. students have spent their freshman years in this environment. They covered the freshman curriculum in mathematics, physics, chemistry, and the humanities through a combination of tutorials, seminars, study groups, and independent study projects in a community which averages 40 freshmen, 20 sophomores, 10 staff members, and 20 undergraduate tutors.

A Watershed Year in 1976

I first joined ESG as a second-semester freshman in 1976, a time of transition for the program as a whole. For one thing, that was the last year in which Peg Norris served as ESG administrative assistant and "den mother." (Her successor, Holly Sweet, is now associate director.) More important, though, 1976 marked the beginning of a change in the character of ESG—from a program which reflected the needs of the rebellious period of the late '60s and early '70s to one which accommodated the different personality of the post-baby-boom "me" generation.

One of the ESG trips brought (l. to r.) Edwin Seidewitz, '84, Carol Beck, '85, Steven Segarra, '84, Clement Wang, '80, and Holly Sweet, staff, to the summit of Mt. Percival in New Hampshire.

Bigger Academic Bang for the Buck With ESG

The Experimental Study Group is experiencing its strongest surge of student interest since 1973. Even though 46 freshmen were accepted for the first term, as compared with 35 at this time last year, 17 applicants still had to be placed on a waiting list.

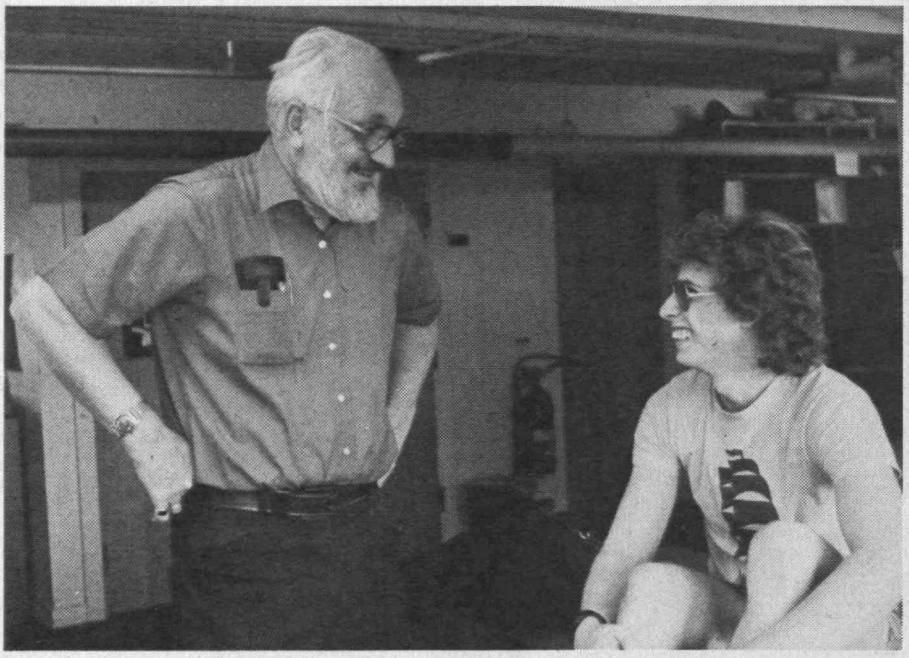
Although accounting for such popularity is chancy, it is known that ESG has had a special appeal for women, minorities and international students. That is one of the facts to emerge from annual ESG assessments.

The fact-gathering exercises also show that ESG is cost-effective, coming in (as of 1981-82) at $49.58 per unit taught, as compared with a cost of $84.42 per unit taught for M.I.T. as a whole.

The extensive use of undergraduate tutors working under faculty supervision, the same feature that makes ESG cost-effective, is widely believed to also enhance its academic effectiveness. One firm believer in that theory is Chemistry Professor Alan Davison. The traditionally bright, quick-learning M.I.T. students have a tendency to think that seeing something once is tantamount to learning it, reports Davison, which causes some concern among faculty members. But ESG tutors soon learn that to teach a concept requires real understanding, he says, and one-time exposure won't suffice.

That may be one reason why ESG students, who enter M.I.T. with academic profiles not noticeably different from those of their non-ESG colleagues, have, by their sophomore years, a median grade point average of 4.2-4.3, as compared with 4.0 for all Institute sophomores. And the median remains constant through the upperclass years. While a recent ESG staff report hastens to note that no direct correlation can be drawn between student experience in the program and subsequent academic performance, something positive seems to be happening.

An opportunity to argue such points is offered by ESG's 15th birthday party, November 9, to which the close to 700 past and present students and staff were invited.



The opportunity to work closely and informally with the faculty, which is a hallmark of ESG, is evident in this photo of Erik Devereux, '85, and Dean Robert Halfman, ESG's director 1974-84.

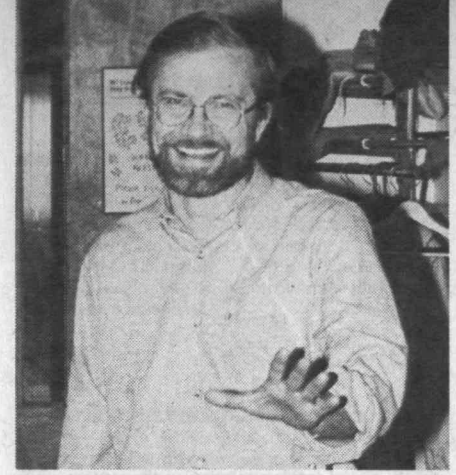
Also distinctive of ESG is its down at the heel but comfortable physical space, where the decor reflects the talents of successive classes and which becomes for many the locus of their lives at M.I.T.

The stereotype of the original ESGer of the late 60s was a vegetarian who lived in Bexley Hall, worked in the Artificial Intelligence Laboratory, and wandered about the campus barefoot in Bermuda shorts in the dead of winter. He regarded "structure" as anathema and took "unconventional" to be the norm, such as learning freshman mechanics through the study of bicycles. Those who took a dim view of the program might have defined ESGers as students who spent most of their time either sleeping on a couch or learning esoteric subjects such as yoga and eastern mysticism, eschewing the staid routine of 8.01, 8.02, and the like.

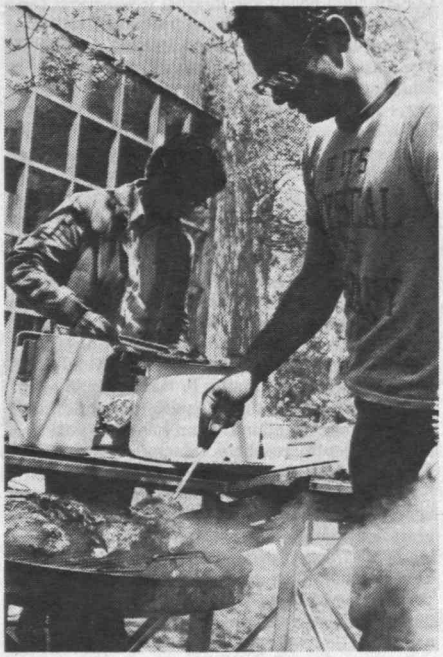
Whatever grain of truth there may have been in those stereotypes, it is nevertheless clear that a great deal of serious learning took place in those early years, for even then ESG produced not only excellent students but also first-rate teachers, innovators, and leaders.

Consider, for instance, Herbert S. Lin, '73, whom one instructor no doubt had in mind when he said the first batch of ESGers were as "loud, as wild-looking, as outwardly self-confident and anti-establishment, as raring to go as any group of students" he had ever run into. Lin and a few other students inaugurated NIGHTLINE, the M.I.T. peer counseling service. Since then, Lin has finished a doctorate in physics, taught in the Peace Studies Program at Cornell, and is now back at M.I.T. with a post-doctoral research fellowship in the Center for International Studies.

Other old ESG standouts included Danny Hillis, '78, who worked on the famous "turtle computer" now being used in the education of pre-school children. There was also the legendary ESG



ESGers were suspected of spending their time sleeping or studying yoga.



(Top) J. Kim Vandiver, '69, the new director of ESG. (Bottom) Ajit Kambil, '85, (left) and Jeff Caplitz, '83, cooking for one of the picnics which help weld ESG students and staff into a true community.

freshman (whose name I never found out) who dropped out of school to make jewelry, returning to complete his bachelor's requirements in three terms!

From ESG's first classes came the "night people," an interesting anthropological group of ex-M.I.T. students who remained in the Boston area years after graduating (or not graduating, as the case may be). They spent their days coping with practicalities like earning a living, and in the evenings they fled back to the ESG nest where they continued to exert an influence over succeeding generations of ESG freshmen.

Changing of the Guard

In the mid-seventies, however, the students who joined ESG began to have very different notions of alternative education. They had a new look, one often described by the old guard as "dull" or "unimaginative." Students were more concerned with preparing for traditional careers and accommodating traditional modes of behavior than with learning yoga, which was a reflection of the shift in society at large. The economy was getting worse, jobs were scarcer, and people were less willing to spend thousands of dollars a year on tuition for something they might very well have learned at home.

ESG adapted to these changes, and there were definite improvements as the program moved into its second decade of existence. People became more committed to the courses that form the backbone of an M.I.T. education. There was even new willingness to employ structure creatively in order to reinforce learning. Small groups centering around senior faculty or student tutors tended to replace the isolated individuality of the past. Even alumni such as Miguel Mitchell, '82, continue to teach standard freshman courses with extraordinary care for motivation and rigor.

At the same time, overachievers multiplied as freshmen became much more ambitious and demanding in their quest for scientific knowledge. Jonathan Weitsman, '81, (now an NSF fellow at Harvard), for example, embarked on such an accelerated pace of learning as a freshman that he was able to take a graduate course in quantum field theory as a sophomore. There were spectacular role reversals, as in the case of an ex-student of mine, Ed Seidewitz, '84, who won a Compton Award last spring; he taught a course in general relativity to members of the ESG physics staff as well as to a couple of freshmen while he was a senior majoring in aeronautics and astronautics and computer science.

A sense of responsibility toward the group replaced the anarchy of previous years, and as a result ESG developed into a more tightly-knit community with more intimate links among its members. This is not to say that ESG became more parochial or less questioning in its attitude toward the world; it still harbors activists of all sorts, from feminists and gay rights advocates to student politicians concerned about life in the Institute at large. Notable are Jonathan Hakala '81, former Undergraduate Association president; Will Doherty '84, Stewart awardee; and Erik Devereux '85, a member of the Committee on Educational Policy and columnist for *The Tech*.

What Next?

ESG is once again in the midst of change. In February, the program suffered the loss of one of its dearest friends, when Professor Emeritus Nathaniel H. Frank, '23, died. Professor Frank, who literally "wrote the book" on freshmen physics before his retirement in 1968, spent virtually every morning for the last 15 years at ESG, unraveling the mysteries of his field and giving students a human and historical perspective on the development of the "new physics" that no text could convey.

Then in July, Professor Halfman handed over the reins of leadership of the program to J. Kim Vandiver, Ph.D.'75, associate professor of ocean engineering. Among Vandiver's objectives for the program are greater involvement of senior faculty in teaching and other activities at ESG. He also wants to see that the results of educational experimentation within ESG—such as the development of new humanities subjects or the Project Athena proposal to use computers in foreign language study—are more widely diffused throughout the Institute.

Meanwhile, all of us who consider ESG our home within the Institute are busy with a new crop of participants who will put the stamp of their own personalities on the program while fulfilling ESG's tradition of individuality, intellectual inquiry, and excitement. □

EDUARDO OLAGUER is a graduate student in meteorology. He came to M.I.T. from the Philippines in 1976, and during his years at the Institute has been both a student and tutor in ESG. He is now a member of the program's physics staff.

PHOTOS: ESG ARCHIVES AND KENNETH M. FLOWERS

I
Civil Engineering

A gift from **George Macomber,** '48, president of the George B.H. Macomber Co. of Boston, has funded two career development chairs in construction management—one in the Department of Civil Engineering and one in the Department of Architecture. Macomber says he intends his gift to address a key problem in the construction industry—fragmentation in the "conceive-design-construct-occupy cycle." The two career development chairs are to be assigned to faculty who are concerned to unify the architecture-construction partnership.

Professor **Daniel Roos,** '61, director of the M.I.T. Center for Transportation Studies, was a member of the National Research Council's Strategic Transportation Research Study of U.S. Highways; the conclusions, reported late last summer: new technology for building and maintaining highways is a critical national need, and this need can be fulfilled only by a major effort to revamp neglected areas of highway research. Four needs should top the research agenda: long-term performance of asphalt, cement, and concrete pavement, maintenance techniques, corrosion protection of concrete bridges, and chemical control of snow and ice. A $30 million annual research program would save at least $600 million a year, the committee said.

Funding from the UPS Foundation is underwriting six new research efforts in the Center for Transportation Studies: probabilistic and economic factors in highway design and maintenance (Professor **Moshe Ben-Akiva,** Ph.D.'73), an international comparative analysis of auto ownership and use (**Mary P. McShane,** S.M.'78, research associate), a planning model for consolidation of less-then-carload shipments (Professor **Stephen C. Graves** of the Sloan School of Management), models for vehicle dispatching to minimize transportation costs (Professor **Richard C. Larson,** '65, Department of Electrical Engineering and Computer Science), development of a computer model to handle shippers' inventory and distribution management (Professor **George A. Kocur,** S.M.'75, and **Yosef Sheffi,** Ph.D.'78), and the continued development of the Transportation Computation Laboratory, now used by several major research and teaching efforts under the direction of Professor Kocur. . . . Meanwhile, **Michael Markow,** S.M.'69, principal research associate, has begun a new research project on issues in highway finance funded independently by the Center for Transportation Studies. He taught a new course last spring on "Analysis Methods in Infrastructure Maintenance and Rehabilitation" (with Professors **David Marks** and **Eric Vanmarcke,** Ph.D.'70). In July he presented a paper at the Fourth International Symposium on Organization and Management of Construction at Waterloo, Ontario, and last April he attended the NSF/ASCE Workshop on Research Needs in Infrastructure. Markow is a member of the advisory committee for the North American Conference on Pavement Management to be held in Toronto.

Carl Martland, '68, principal research associate, was vice-president of program for the 25th Annual Meeting of the Transportation Research Forum in Boston in October. . . . Professor **Nigel Wilson** has been named head of the department's Transportation Systems Division.

Associate Professor **Oral Buyukozturk** has begun a new project for the National Science Foundation, "The Behavior of Confined Concrete in Cyclic Loads with Applications to Bridge Structures" and has had a paper accepted for publication in the *TRB Record* on "Design Problems in Segmental Concrete Bridges." . . . Professor **Richard de Neufville,** '60, presented his paper on designing airport terminals for passengers at the ASCE Specialty Conference on Airports in Los Angeles in June. He is also serving as a consultant with **Amedeo Odoni,** '65, professor of aeronautics and astronautics, to the government of New South Wales on a $1.5 million planning study for the second Sydney airport.

Max M. Ulrich, S.M.'51, has resigned as president of Ward Howell International, Inc., New York City, to become the company's chairman and chief executive officer. . . . **Bates C. Burnell,** S.M.'49, is currently executive vice-president for international relations of Morrison-Knudsen Co., Inc., Boise, Idaho, as well as chairman and chief executive officer of Morrison-Knudsen International Co., the firm's subsidiary. . . . **Cordell W. Hull,** S.M.'57, has been made senior vice-president (as well as chief financial officer) of Bechtel Group, Inc., San Francisco, Calif. . . . **Guillermo J. Vicens,** Ph.D.'70, has been named a vice-president of Camp Dresser & McKee, Inc., environmental consultants, Boston, Mass., responsible for managing the firm's new business ventures in the federal sector and the water resources group in the Northeast. Vicens, formerly a research assistant and assistant professor in the Water Resources Division in the department at M.I.T., has served as project manager for studies involving hydrology, water resources systems, stormwater management, and coastal engineering.

Jon Hagstrom, S.M.'65, director of research of CBI, Inc., Plainfield, Ill., has been elected a vice-president. Joining CBI in 1961, Hagstrom served as field construction and design engineer and later as manager of CBI's Design Engineering Department, Special Structures and Design Department, and Stress Analysis Group. . . . **Jack Kinstlinger,** S.M.'54, has joined Kidde Consultants, Inc., Baltimore, Md., as executive vice-president and chief executive officer, responsible for the management of the Eastern Division. He was formerly vice-president of Daniel, Mann, Johnson and Mendenhall. . . **George Bugliarello,** Sc.D.'59, president of the Polytechnic Institute, New York City, as been appointed by New York Mayor Edward I. Koch, to the panel of a city Commission for Science and Technology. The panel of 21 will serve to "encourage the growth of scientific and technological activities and to recognize scientific undertakings to enhance New Yorkers' well-being and increase their ability to meet the challenges of the future." . . . **Eng-Seng Poh,** S.M.'81, is presently working as transportation engineer with the Provisional Mass Rapid Transit Authority, Singapore, which is in charge of the planning, construction, and implementation of the system. Construction began late in 1983.

Warren W. Yee, S.M.'41, a prominent Detroit professional engineer, passed away in April 1984. Yee was a partner in the Detroit firm of Harley, Ellington, Pierce, and Yee, Associated, and five years ago founded Biotech Research, Washington, D.C.

II
Mechanical Engineering

Fluid flow in the eye and the flow of other biological fluids through microporous materials is the subject of research by **C. Ross Ethier,** S.M.'83, during the current year under a fellowship from the Whitaker Health Sciences Fund at M.I.T. . . . A similar grant to **Timothy P. Harrigan,** '80, will fund a continuation of his studies on lubrication mechanisms in the human hip joint, his goal being to identify mechanical factors in osteoarthritis.

Professor **Herbert H. Richardson,** '53, who was head of the department at M.I.T. for nearly ten years before becoming associate dean of engineering in 1982, has moved to College Station, Tex., to be dean and vice-chancellor for engineering at Texas A & M University. He'll soon carry the additional title of distinguished professor of engineering.

Professor **Nam P. Suh,** '59, who has been directing the M.I.T. Laboratory for Manufacturing and Productivity, is now on leave—tapped by the White House to be assistant director of the National Science Foundation in charge of NSF's expanding program in engineering research and education. *Science* magazine says the NSF engineering directorate, which Suh heads, is responsible for spending some $147 million, about 10 percent of NSF's total budget for 1984-85. Formerly a research associate and (since 1983) its assistant director, **George Chryssolououris** has been named associate director of the Laboratory for Manufacturing and Productivity. In making the appointment, Professor Suh, laboratory director, cited Dr. Chryssolouris' "several outstanding contributions to the laboratory."

Their 1983 paper on "Analysis of Hydrocarbon Emissions Mechanisms in a Direct-Injection Spark-Ignition Engine" has brought four members of the M.I.T. family the 1984 Hornig Award of the Society of Automotive Engineers presented in Baltimore at the SAE Fuels and Lubricants Meeting in October. The winning authors: **Anthony J. Giovanetti,** Ph.D.'82, now an associate research engineer at United Technologies Corp.; **Jack A. Akchian,** research engineer in the M.I.T. Energy Laboratory; Professor **John B. Heywood,** Ph.D.'65, director of the Sloan Automotive Labc ratory at M.I.T.; and **E. F. Fort** of Integral Technologies, Inc.

Kenneth Astill, Ph.D.'61, associate dean of engineering and professor of mechanical engineering at Tufts University, has been elected to the Engineering Societies of New England Executive Committee. Astill has been active in the Boston section of the American Society of Mechanical En-

gineers, served as consultant for many local firms, and is co-author of *Numerical Algorithms*, published by Addison-Wesley. . . . **Philippe Villers,** S.M.'60, formerly president, is now chairman of Automatix, Inc., Billerica, Mass. . . . **Richard A. Rabinow,** S.M.'68, former executive assistant to the president of Exxon USA, has become the manager of Exxon's Baytown Refinery.

Randy M. Campbell, S.M.'71, of Rochester, Mich., passed away on November 22, 1982; no details are available.

III

Materials Science and Engineering

To integrate the problems of materials and manufacturing is the goal of **H. Kent Bowen,** Ph.D.'71, Ford Professor of Engineering, as director of a new Manufacturing Systems Program at M.I.T. Bowen has been director of M.I.T.'s Materials Processing Center, and now he will be in charge of programs to capitalize on new materials developments to increase productivity in manufacturing and high-technology systems. Bowen joined the faculty as assistant professor of ceramics in 1970 while still a graduate student.

Thirteen members of the M.I.T. community were among featured speakers and authors at the 1984 Metals of Congress of the American Society of Metals in Detroit last September:

☐ **Nathan E. Promisel,** '29, formerly executive director of the National Materials Advisory Board of the National Research Council, delivered the distinguished lecture on materials and society: "Of Perspectives, Issues, and Politics in Materials Technology."

☐ **Richard P. Simmons,** '53, president and chief executive officer of Allegheny Ludlum Steel Corp., was the keynote speaker for an international conference on new developments in stainless steel technology; his topic: "The Future for Stainless Steel in a Rapidly Changing World." In the same conference, Professor **Ronald M. Latanision,** director of the H. H. Uhlig (Ph.D.'32) Corrosion Laboratory at M.I.T., provided a keynote address on "Corrosion Resistance of Stainless Steels Processed by Rapid Solidification Technology."

☐ **Robert Mehrabian,** '64, dean of the College of Engineering at the University of California, Santa Barbara, provided an overview paper on "Process Modeling and Control Needs for Advanced Materials" for a series of sessions on nondestructive microstructure characterization and process control.

☐ Professor Emeritus **Michael B. Bever,** Sc.D.'44, was the keynote speaker for a series of sessions on automotive recycling.

☐ Two members of the faculty were among lecturers at a symposium on interface migration and control of microstructure: Associate Professor **Samuel M. Allen,** Ph.D.'75, on antiphase boundaries in alloys and Assistant Professor **Carol V. Thompson, III,** '76, on secondary grain growth in ultrathin films of silicon and germanium.

☐ Six members of the department contributed to two papers for a two-day symposium on failure models in composites: **James A. Cornie,** principal research associate in the Materials Processing Center, was the senior author of both papers, and he was joined by Professor **Merton C. Flemings,** '51, and four gradaute students in the department: **Robert G. Dixon, Mehmet N. Gungor,** S.M.'62, **Howard S. Landis,** and **Andreas Mortensen.**

Gerald S. Meiling, Sc.D.'59, has been named director of glass-ceramic development in the Research and Development Division at Corning Glass Works, Corning, N.Y.; he has been director of technical products development. Also at Corning **J. Robert Booth,** Sc.D.'72, has been named manager of product development, Technical Products Division. . . . **David N. French,** Sc.D.'58, has formed David N. French, Inc., Metallurgists, Northborough, Mass. The consulting firm offers specialized services on problems related to boilers and steam generated equipment.

Four alumni have been named fellows of the American Society for Metals, in recognition of their "contributions to the advancement of metals and materials technology and use": **John H. Walsh,** Sc.D.'55, senior special advisor (coal), Department of Energy, Mines and Resources, Government of Canada, Ottawa; **Larry P. Kaufman,** Sc.D.'55, vice-president and director of research of ManLabs, Inc., Cambridge; **Richard W. Hertzberg,** S.M.'61; New Jersey Zinc Professor of Metallurgy at Lehigh University; and **Nev A. Gokcen,** Sc.D.'51, research supervisor at the Albany Research Center, U.S. Bureau of Mines, Albany, Ore. . . . **Milton Stern,** Sc.D.'50, former senior executive vice-president of Stauffer Chemical Co., Westport, Conn., has become the firm's vice-chairman.

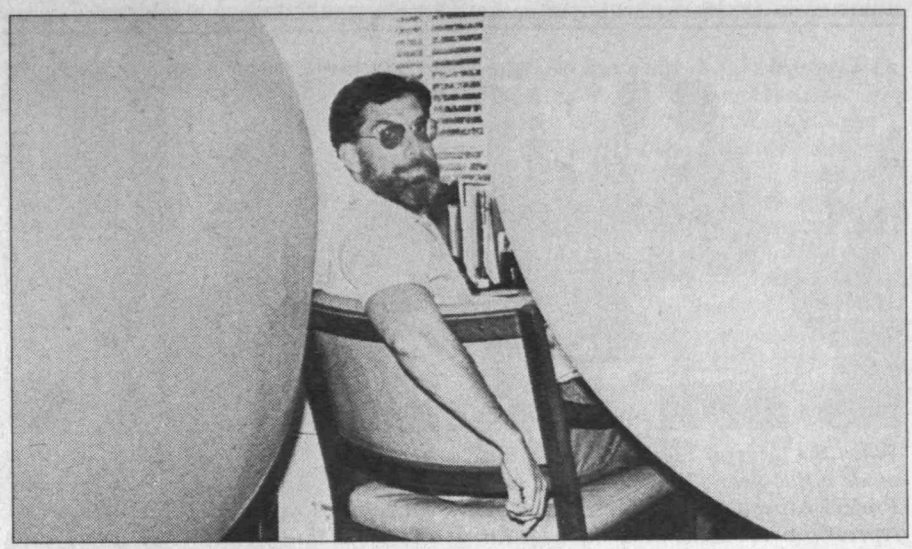
Two deaths were reported by the Alumni Association, with no further details available: **Earl C. Roberts,** Sc.D.'50, of Enumclaw, Wash., and Boeing Aerospace Co., on June 2, 1984; and **Harvey J. Lander,** S.M.'55, affiliated with the General Electric Co., Cincinnati, Ohio, in 1983.

IV

Architecture

"Architecture and geometry are truly symbiotic and cannot exist without each other," writes **William Blackwell,** B.Arch.'53, in his new book, *Geometry in Architecture* (John Wiley & Sons, 1984, $34.95). But for most architects, says Blackwell, geometry is only a tool, despite its functional, technical, and aesthetic qualities when applied to design. Blackwell is a senior architect with Bechtel Civil and Minerals, Inc., San Francisco.

Scott L. Danielson, M.Arch.'62, writes, "I've been promoted to technical director for architecture at Parsons Brinckeroff, architecture, engineering, and planning, a firm with 1,200 employees nationwide. Recently finished conceptual design for the Department of Energy proposal for a particle physics research facility (superconducting super-collider) estimated to cost $3 billion." . . . **Ann Beha,** M.Arch.'75, of Ann Beha Associates, a Boston architectural firm, specializing in historic preservation and building rehabilitation, has been retained by the Commonwealth of Massachusetts to prepare a Historic Structures Report for the Massachusetts State House in Boston, to be submitted in Decem-



As the 1984-85 academic year began, Professor Robert J. Silbey returned to a surprise in his Chemistry Department office: two large balloons, one pink, one white, a prank for which two graduate students ultimately claimed responsibility. (Photo: Calvin Campbell)

Infrastructure Needs Are a Neglected Challenge

During the last decade, while the need for rebuilding the U.S. infrastructure of roads, bridges, dams, railroads, and pipelines has become increasingly apparent, the productivity of the U.S. construction industry has decreased by 20 percent, says Joseph M. Sussman, Ph.D.'68, head of the Department of Civil Engineering. It's an inconsistency that presents an unprecedented new opportunity, Sussman believes.

The crumbling state of the infrastructure—estimates of the cost of rebuilding range from $500 million to $3 billion, he said—is not just a matter of conventional repairs. "It is an opportunity to redevelop," Professor Sussman told the 50th anniversary celebration of the Association of Finnish Civil Engineers in Helsinki late last summer—to add "new intellectual substance."

Yet, Sussman said, the U.S. civil engineering industry is not investing in a key ingredient for enhancing productivity—long-term research. "With all the talk about needs, no one is talking about what are the real opportunties here.

"Clearly, new technology development is critical to the question of productivity," Sussman declared. Furthermore, he said, "the civil engineering academic community must take the lead in this, integrating new science and technology into its curricula and research in order to position itself as the exciting, vibrant field of the future." ☐

When the General Electric Foundation made a five-year $1 million grant to Project Athena early this fall, three GE representatives came to Cambridge for a look. Left to right: Dean Gerald L. Wilson, '61, of the M.I.T. School of Engineering; William J. Cimonetti, vice-president and general manager of GE's International and Transportation Division; Walt Keating, manager of technical services for GE in Burlington, Vt.; President Paul E. Gray, '54; Eric C. Johnson, '67, assisant dean of engineering for resource development; and William A. Orme, secretary of the GE Foundation. (Photo: Calvin Campbell)

ber. "The report would serve as a reference manual for future historic preservation and restoration work," says Beha.

The late **Marvin E. Goody,** M.Arch.'51, a steward of Boston's Public Garden who "cherished it and felt an abiding call to take care of it and preserve it for the delight of all persons," is honored by a memorial in the Public Garden designed by his wife, Joan Goody. The memorial is a broken circle of eight rose-gray granite benches around the perimeter of the stonework at the base of the flagpole near the Charles Street entry to the Garden. The inscription on the inward side of the dominant bench reads: "In Memory of Marvin E. Goody, 1929-1980, Architect, Teacher, Friend to the Public Garden. To See His Work Look Around You."

V

Chemistry

Two major awards of the American Chemical Society came to members of the M.I.T. chemistry "family" during the 1984 annual meeting of ACS in Philadelphia late last summer. **Alan S. Michaels,** '44, was named for the 1985 ACS Award in Separations Science and Technology, with a $3,000 honorarium provided by Rohm and Haas Co.; and **Peter G. Schultz,** a National Institutes of Health Postdoctoral fellow at M.I.T. this year, was named to share the society's Nobel Laureate Signature Award for Graduate Education in Chemistry; the latter includes a $6,000 prize sponsored by J.T. Baker Chemical Co. Both presentations will be made at the 1985 spring meeting of ACS in Miami.

Members of the M.I.T. chemistry family had major roles in the annual meeting of the Council for Chemical Research at the University of California late in September. Among the speakers: Professor **Christopher T. Walsh** of M.I.T. on "Nickel-Containing Enzymes in the Biogenesis of Natural Gas" and Professor F. Albert Cotton of Texas A & M University on "Metal-Metal Bonds in Theory and Practice." **P.L. Thibaut Brian,** Sc.D.'56, of Air Products and Chemicals, Inc., Allentown, Pa., and **Richard I. Mateles,** '56, of Staufer Chemical Co. served as session chairmen.

Namik K. Aras, Ph.D.'64, professor of chemistry at Middle East Technical University, Ankara, Turkey, has been awarded the 1984 Tubitak Science Prize by the Scientific and Technical Council of Turkey. Aras was recognized for his contribution in the field of nuclear chemistry; the award is the highest scientific prize given in Turkey. His recent activities have included a study of ranges and energies of fragments from spontaneous fission of Cf-252, nuclear spectroscopy, and study of atmospheric pollutions by nuclear techniques. Aras is the author of over 50 articles in nuclear fission, nuclear decay schemes, and trace element analysis in environmental and biological samples. . . . **Robert Frye,** Ph.D.'76, research specialist at General Electric Silicon Products Division, Waterford, N.Y., presented a paper, "A Novel Flame Retardant Technology for Polyolefins," at the American Chemical Society's 188th National Meeting in Philadelphia, Penn., last August.

Leonard Baker, Ph.D.'60, has been appointed director of corporate technology for Union Carbide Corp., Westport, Conn. Baker joined Union Carbide in 1959 as a chemist and since then has held a variety of positions, most recently vice-president of technology for the Specialty Chemicals Division. . . . **Richard D. Fink,** Ph.D.'62, professor of chemistry at Amherst College, has been appointed dean of faculty. Fink, a specialist in chemical physics, has been on the Amherst faculty since 1964, serving as chairman of the department for three years. . . . **William H. Zoller,** Ph.D.'69, former professor of chemistry at the University of Maryland, College Park, now holds a similar post at the University of Washington.

Robert W. Gleason, Ph.D.'60, professor of chemistry and dean of sciences at Middlebury College, Vt., has recently been named dean of the faculty, responsible for recruiting, academic budgets, and other matters related to the faculty in the humanities, natural sciences and social sciences. . . . **Robert A. Young,** Ph.D.'68, has been named president of International Business Machines Instruments, Inc., Danbury, Conn. Young joined IBM in 1968 and has been affiliated with the company's instruments business since 1975.

B.A. (Ben) Tefertiller, Jr., Ph.D.'66, has been appointed a project director in the Innovation Development Department of the Dow Chemical Co., Midland, Mich. Also at Dow, **John A. Schneider,** Ph.D.'66, senior project manager for oxazoline in the Specialty Chemicals and Functional Products Commercial Opportunity Development Group, has taken on the additional responsibility of developing the commercial and technical strategy for the Dow catalyst business.

Mortimer Nickerson, Ph.D.'37, who worked as staff associate and industrial consultant in plastics for Arthur D. Little, Inc., Cambridge, passed away on April 29. He resigned from ADL in 1969 and moved to Florida in 1976. . . . **Elizabeth Sheffield Cross,** Ph.D.'44, of Kirkwood, Mo., passed away on February 6, 1984; no further details are available.

VI

Electrical Engineering and Computer Science

Bernard M. Gordon, '48, founder of Analogic Corp., is moving to found a new educational institution devoted to high-technology fields and their management in Wakefield, Mass. The Gordon Institute, reported to be funded with at least $10 million from Gordon, would start classes next September with as many as 50 students. Among its trustees: **Jordan J. Baruch,** '47, former U.S. undersecretary of commerce for science and technology, and **Gerald L. Wilson,** '61, dean of engineering at M.I.T. A glimpse of Gordon's point of view can be seen in his commencement address last June at Western New England College, Springfield, Mass.: ". . . having information and knowing what to do with it are not the same thing," he said.

"Models, models—who needs models?" asks **Donald B. Rosenfield,** S.M.'71, of Arthur D. Little's Operations Research Section. Everyone, says Rosenfield, answering his own question. "Decision support models for logistics planning will be a necessary requirement for effective competitive strategy in the future," Rosenfield told an ADL forum in Boston last summer. Meanwhile, Rosenfield's colleague, **Richard C. Norris,** Sc.D.'62, was telling the same ADL forum audience that computer-based information processing is now entering a new phase: inter-company as well as intra-company. Electronic data interchange, he said, "will have a profound influence on the functional roles and relationships of manufacturers, distributors, brokers, customers, shippers, agents, and carriers."

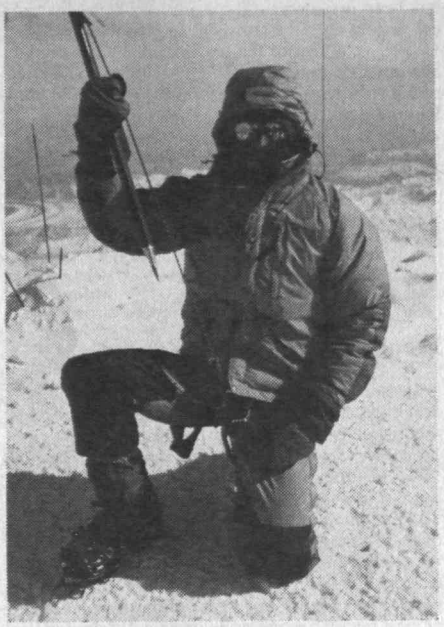
Edward F. Fredkin, adjunct professor in the department at M.I.T., has won the 1984 $20,000 Dickson Prize of Carnegie-Mellon University. The award recognized Fredkin's theoretical research in physics and computation, the field of his M.I.T. teaching. . . . **David D. Clark,** Ph.D.'77, principal research scientist in the department at M.I.T., has been elected a director of Proteon, Inc., Natick, Mass. . . . **Pasquale V. Costa,** S.M.'69, former executive vice-president of GCA Corp., Boston, a maker of semiconductors, is currently chairman, president, and chief executive officer of Robotic Vision Systems, Inc., Melville, N.Y. . . . **Arthur Bisberg,** S.M.'57, former senior vice-president of EG&G, Inc., Wellesley, Mass., has been promoted to corporate vice-president.

William F. Henderman, Jr., S.M.'71, writes, "I was recently appointed to the Gas Research Institute's Economic Advisory Group." . . . **Paul Smith,** S.M.'61, former vice-president for product management of ITT Courier Terminal Systems, Tempe, Ariz., has become senior vice-president/chief technical officer of Summagraphics, Fairfield, Conn., a digitizer and computer graphics firm. . . . **Martin Patt,** S.M.'64, who teaches electrical engineering at the University of Lowell, Mass., was appointed research fellow at the Hanscom Air Force Base Geophysics Laboratory by the Southeastern Center for Electrical Engineering Education.

Samuel Labate, S.M.'48, retired chairman of Bolt Beranek & Newman, Inc., Boston, has become director of EPSCO, Inc., Westwood, Mass. . . . **Harrison E. Rowe,** Sc.D.'48, a prominent researcher in the field of communications who has been a member of the technical staff at Bell Laboratories since 1952, has been appointed to the newly endowed Anson Wood Burchard Chair of

Electrical Engineering at Stevens Institute of Technology, Hoboken, N.J. Rowe has specialized in the behavior of non-linear elements, electromagnetic theory, and noise and modulation theory. . . . **Jose B. Cruz,** S.M.'56, associate head of the Department of Electrical and Computer Engineering, University of Illinois, Champaign, has been nominated for the office of the 1985 president-elect of the Institute of Electrical and Electronics Engineers (IEEE). Cruz has held a variety of posts in the IEEE, and he is now serving on the board of directors and as vice-president for publication activities.

Dean A. Lyon, Sc.D.'37, professor of electrical engineering from 1968 to 1974 at the University of New Haven, Conn., passed away on June 9, 1984. Lyon, a research scientist for the Navy during World War II, invented the first practically useful optical anti-reflection coating. Following his wartime service, he continued this work as a self-employed scientist, and he was also active in genealogical research and a member of the New England Genealogical Society. . . . Two deaths were reported by the Alumni Association, with no further details available: **Robert B. Martindale,** S.M.'57, of Seattle, Wash., died in a boating accident on July 9, 1984; and **Carl G. Blanyer,** S.M.'54, of Thousand Oaks, Calif., on March 18, 1984.



Associate Professor B.K.P. Horn, Ph.D. '70, in the Department of Electrical Engineering and Computer Science, atop the 20,320-foot summit of Mt. McKinley. On June 6, under the organization of the Rainier Mountaineering Club, Horn and 13 fellow climbers began their ascent up the highest mountain in North America; 12 arrived at their destination on June 18.

In the past 70 years, more than half the attempts to reach the peak have been unsuccessful. Climbers found it necessary to turn back, owing to sudden storms, mishaps, the high altitude (barametric pressure of around 13.6"), and freezing temperatures (−20°F.)

VII
Biology

Studies on cardiac physiology by **Deborah Burstein,** S.M.'82, are continuing in the department at M.I.T. following renewal of Burstein's fellowship from the Whitaker Health Sciences Fund. . . . **Ira Herskowitz,** Ph.D.'71, professor and vice-chairman of biochemistry and biophysics and head of the Division of Genetics at the University of California, San Francisco, has received an Academic Senate's Distinction in Teaching Award, in recognition of his teaching in biochemistry and genetics. Herskowitz is vice-president of the Genetics Society of America and winner of the 1983 Eli Lilly and Co. Award in Microbiology and Immunology for his major discoveries in genetics of mating type in yeast and regulation of temperate bacteriophages.

In the May 27, 1984, edition of the *Sunday Cape Cod Times,* **Alton Garland,** '34, born in 1908 in East Sandwich, Mass., reminisced about his years growing up there. He tells of how time has transformed his town's once rural farm community into a summer "tourist haven." As stated in the article, "Shopping centers rise where cattle used to graze . . . (and) luxury condos offer sweeping views of the sea where long ago there were only the humble cottages of fishermen and the racks of drying cod."

VIII
Physics

George W. Clark, Ph.D.'52, is the first member of the M.I.T. faculty to hold the Breene M. Kerr Professorship named for its donor, a member of the Class of 1951 whose generosity has "greatly enriched the life of the Institute" over a period of many years, says President Paul E. Gray, '54. Clark is internationally recognized for his contributions to the field of high-energy astrophysics—high-energy cosmic rays and x-ray astronomy. Kerr, who studied geology at M.I.T., is a former president of the Alumni Association, a life member of the Corporation, and a long-time member of the visiting committee to the Department of Earth, Atmospheric, and Planetary Sciences.

After being voted out of the position as chairman of M/A-Com, Inc., Burlington, Mass., in 1982, **Lawrence Gould,** Ph.D.'50, has made a good recovery. In 1968 Gould made a quiet investment in a "fall-back" position which in 1973 turned into full-ownership of Point Sebago—a luxury resort camp in Maine to which he now devotes full time. "I'm perfectly delighted where I'm at," he told Jane Meredith Adams of the *Boston Globe* last summer.

X
Chemical Engineering

Chong Y. Yoon, Sc.D.'59, is currently vice-president of the fine chemicals division at the Upjohn Co., Kalamazoo, Mich. . . . **James L. Fischer,** S.M.'55, retired on June 30, 1984, as executive vice-president and principal financial officer of Texas Instruments, Inc., Dallas, Tex. . . . **Paul R. Larson,** S.M.'54, former general manager of the Chevron Corp., San Francisco, Calif., has been promoted to vice-president of manufacturing for Chevron U.S.A., Inc., effective August 1, 1984. . . . **Ronald O. Baukol,** S.M.'60, has been named vice-president and general manager of Riker/3M, St. Paul, Minn., responsible for the worldwide operations of Riker, which is 3M's international pharmaceutical subsidiary.

Michael Modell, Sc.D.'60, of Modar, Inc., Natick, Mass. gave a paper on "Destruction of Dilute Hazardous Wastes by Supercritical Oxidation" last September at the First International Symposium on Emerging Hazardous Waste Management Technology in Odense, Denmark. . . . **Alexis T. Bell,** Sc.D.'64, professor at the University of California, Berkeley, has been awarded the 1984 Donald L. Katz Lectureship in Chemical Engineering at the University of Michigan. The lectureship is awarded annually to a distinguished researcher in chemical engineering and petroleum technology. . . . **Allan S. Offman,** Sc.D.'53, professor in the Center for Bioengineering and the Department of Chemical Engineering, at the University of Washington, Seattle holds the 1984 Clemson Award for outstanding contributions to the scientific literature of biomaterials. The presentation was made last spring at the Second World Congress on Biomaterials.

Richard A. Wuopio, S.M.'60, is currently manager of engineering evaluation for Chevron Chemical Co., San Francisco, Calif. . . . **Irwin S. Zonis,** S.M.'52, employed with Essex Chemical Corp., Clifton, N.J. for 25 years, has been promoted to senior vice-president. Zonis will continue as president and chief executive officer of Essex Industrial Chemicals, a subsidiary of Essex Chemical. . . . **James B. McNeely,** S.M.'57, reports, "I am now director of materials development for the Astropower Division of Astrosystems, Inc. The Astropower Division has been recently created to do research on crystalline semiconductor thin films for photovoltaic applications." . . . **Elisabeth M. Drake,** Sc.D.'58, Cabot Professor and chairman of the Department of Chemical Engineering at Northeastern University, Boston, has been named a fellow of the American Institute of Chemical Engineers (AIChE). Drake is the second woman to receive this honor in AIChE's 75-year history, and she was recognized for "her expertise in cryogenics and hazardous materials risk management . . ." . . . **Robert B. Flanders,** S.M.'58, writes, "I retired once in 1977—didn't like it—so I got me a good job (at NRC, Inc., Newton, Mass.) working in tantalum applications. However, next year I'll be 70 years old and will have to retire again. Gonna have to like it this time."

Chaplin Tyler, S.M.'23, a retired engineer formerly employed by E.I. du Pont de Nemours & Co., has been elected a Fellow of the American Institute of Chemical Engineers, recognized "for his expertise in the economic aspects of chemical engineering and of the chemical industry." . . . **Joseph R. Cobb,** S.M.'49, formerly manager of technical systems development for information services at the Phillips Petroleum Co., Bartlesville, Okla., has been promoted to manager of technical services for research and development. . . . **Rudolph T. Greep,** S.M.'34, has been elected a trustee of the North Yarmouth (Mass.) Academy for 1984-85.

Bhupendra N. Khetani, '60, director of worldwide new business development at Owens-Illinois, Toledo, Ohio, has been appointed to the additional position as vice-president of the Plastics and Closures Group. . . . **James Lago,** S.M.'47, vice-president—process and development for the Merck Sharp and Dohme Research Laboratories, Rahway, N.J., has received the highest honor that Merck & Co. bestows on its scientists—the Scientific Award of the Board of Directors. Logo's major contributions have been the productive development of marketing of "Aldomet," Merck's antihypertensive, and "Mefoxin," the company's broad spectrum injectable antibiotic. . . . **Roy N. Levitch,** Sc.D.'66, writes,

"I'm currently manager of business planning for Solavolt International, the partnership formed by the photovoltaic subsidiaries of Shell Oil and Motorola. Solavolt is manufacturing and selling solar modules made from sliced silicon wafers while we work to introduce our new silicon ribbon process. I, my wife Janine (former Course X 'techretary'), and our three sons live in Scottsdale, Ariz., near Solavolt's Phoenix operations."

Arthur L. Merrifield, '35, of Cincinnati, Ohio, passed away as a result of a heart attack on April 13, 1984; no further details are available.

XI

Urban Studies and Planning

Carol L. Carter, M.C.P.'79, holds a 1984-85 fellowship from the Whitaker Health Sciences Fund. At M.I.T. this year she's studying the Massachusetts hospital containment law, legislation designed to prevent overexpansion of the state's hospital facilities. . . . **Karen Polenske,** professor of regional political economy and planning, has received an M.I.T. Graduate Student Council Award for Teaching. She is teaching "Transportation Infrastructure in Developing Countries" this fall with Professor **Ralph Gakenheimer**. Her paper on an assessment of infrastructure in Massachusetts was presented last May at an International Workshop on the Building Sector at Boston University. . . . Meanwhile, Gakenheimer is teaching for the first time this fall a new course on "Infrastructure in Developing Countries"; and he is also helping to prepare a core course "Planning and Institutional Processes" for the new master's degree specializing in developing countries. Last summer he worked as a consultant in the National Urban Development Study for Indonesia (Jakarta) on transportation and urban services. He was also in charge of the infrastructure part of a summer course in June on "National Urban Policy and Infrastructure in Developing Countries," presented by the developing countries faculty of the department.

Vilma Barr, '73, reports that she is manager of the Public Relations Center of Harza Engineering Co., Chicago, Ill., and heads the Friends of Downtown's Committee to establish an urban design review process for the city. She is also co-author of *Designing to Sell—The Complete Guide to Retail Store Planning and Design*, to be published Spring, 1985. . . . **James E. Wallace,** Ph.D.'72, has completed a national study of the Fair Housing Assistance Program for HUD.

XII

Earth, Atmospheric, and Planetary Sciences

Thomas H. Jordan, formerly professor of geophysics at the Scripps Institution of Oceanography, has joined M.I.T. as Robert R. Shrock Professor. Professor **William F. Brace,** '46, describes him as "a superb teacher and a scientist of international reputation"—a major contributor to the understanding of plate tectonics in the deepest layers of the continents. Jordan holds three degrees from Caltech, and he won the AGU's Macelwane Award as the outstanding young geophysicist of 1983.

Thomas F. Malone, Sc.D.'46, natural science fellow at Resources for the Future, Washington, D.C., and scholar-in-residence at Saint Joseph College, West Hartford, Conn., has been awarded the world's oldest and most prestigious meteorological scientific prize—the International Meteorological Organization Prize. Malone began his career as a member of the faculty at M.I.T.; established the Travelers Weather Service and Travelers Weather Research Center on the way to becoming senior vice-president and director of research at the Travelers Insurance Co., Hartford; and finally was for 10 years director of the Holcomb Research Institute of Butler Univeristy. He has been president of the American Meteorological Society and of the American Geophysical Union, an officer of the International Council of Scientific Unions, and foreign secretary of the National Academy of Sciences 1978-82). Last fall Malone moderated a "Moscow Link" in which leading U.S. scientists discussed the scientific aspects of the so-called "nuclear winter," during a telecast via satellite, with scientists in Moscow.

Dan T. Rogers, S.M.'54, of Bountiful, Utah, passed away on June 21, 1980; no further details are available.

XIV

Economics

Professor **Martin L. Weitzman** of M.I.T., who is described as "one of America's leading economic theorists," is the author of *The Share Economy: Conquering Stagflation* (Harvard University Press, 1984, $15). It's a statement of Weitzman's proposal that widespread adoption of alternative wage payment systems in which firms share profits or revenues with their employees provides "immunity" against stagflation. "We do not have to live with stagflation if we do not want to," writes Weitzman. "The share economy is a robust natural enemy of unemployment and inflation."

Larry Hirschhorn, Ph.D.'71, a senior research analyst at the Management and Behavioral Science Center at the University of Pennsylvania, has written *Beyond Mechanization: Work and Technology in a Post-Industrial Age*, published by the M.I.T. Press last October. Hirschhorn argues that "the common conception that computers eliminate the need for human skill and judgment is wrong." The flexibility of modern systems and the fact that they fail in unexpected ways argue for broader labor responsibilities that in turn require new methods of management. . . . **Kenneth T. Rosen,** Ph.D.'74, who is professor of economic analysis and policy at the University of California, Berkeley, has been elected a director of the Golden West Financial Corp., Oakland, Calif. . . . . **Kumar N. Ramohalli,** Ph.D.'71, is on leave from the Jet Propulsion Laboratory to the University of Arizona.

Douglas W. Woods, Ph.D.'70, has been named head of the Department of Social Science and Policy Studies at Worcester Polytechnic Institute, for a five-year term. Woods, who joined WPI in 1970, is a specialist in industrial organization and public policy, econometrics, financial management, and managerial economics.

Ronald L. Teigen, Ph.D.'62, on the Economics Department faculty at the University of Michigan, Ann Arbor, passed away on March 21, 1984; no further details are available.

XV

Management

James Orlin, associate professor of operations research, holds a Fulbright Fellowship for the current year to research heuristic design and development in the Netherlands. During the past academic year, he served as associate editor of two professional journals—*Operations Research* and *Management Science*—and contributed to *Networks, Mathematical Programming, Operations Research, Journal of Algorithms* and *Mathematics of Operations Research*. He was also a participant in the SIAM Conference on the Applications of Discrete Mathematics.

Thomas Maganati, professor of operations research and management and head of the Management Science Area in the school, was faculty chairman for the executive education course in "Strategic Management in Transportation," offered jointly by the M.I.T. Center for Transportation Studies and the Sloan School of Management in May. He is the co-author of "Network Design and Transportation Planning: Models and Algorithms" (with R.T. Wong) in *Transportation Science*, and he has recently begun a new project for NSF on "Network Design and Combinatorial Optimization."

For a taste of good news, read *Creating Abundance: America's Least-Cost Energy Strategy* (McGraw Hill, 1984, $14.95). Its purpose is to present and support its authors' contention that the U.S. is winning the energy battle "by simply seeking the least costly means of providing the services, such as comfort and mobility," that energy provides. Among the authors: **Roger F. Naill,** S.M.'72, vice-president for energy planning services of AES, Inc.

Ernest I. Glickman, S.M.'64, is currently executive vice-president of the Human Resources Group at Harbridge House, Inc., Boston. . . . **John N. Maguire,** S.M.'60, has retired as president and chief executive officer of Software AG Systems Group, Inc., Reston, Va.; he retains the title of chairman. . . . **David G. Benson,** S.M.'67, reports that he is now chief executive of the Venice Simplon-Orient Express, with headquarters in London. . . . **Fred Cohen,** S.M.'80, has recently left Intel Corp. to join Mentar Graphics as product line manager for physical CAD tools. . . . **Andrew Wasserman,** S.M.'75, reports from Piedmont, Calif.: "For the past three years, I have had my own computer consulting company—Wasserman and Associates, Inc." . . . **Joseph V. Iemolo,** S.M.'62, reports that on April 1 he was promoted to major systems product manager for national accounts at Sperry Computer Sustems, Wayne, Penn., covering airlines, energy companies (oil and gas), Bell operating companys and other communications services (RCA, NBC, Western Union and Hertz).

Management of Technology Program

Geoffrey N. Andrews, S.M.'82, was at M.I.T. on August 28 and had lunch with Jane Morse and two of the current students. He is enjoying an expansion of his position as chief project engineer with Pilkington PE, as he now reports directly to the technical director of the company. Geoff was on his way to Pittsfield, Mass., and was able to stop in Cambridge for a day. . . . **Charles A. Berry,** S.M.'83, and his wife Irene had their first child, Isla Moffatt Berry, born at 3 a.m. on July 20. Congratulations! . . . **Erik Chaum,** S.M.'84, has a name for his new company—Ten Point Systems, Inc.—located on Massachusetts Ave. in Cambridge. Last we heard from him he was making good headway on a prototype system.

Moises J. Goldman, S.M.'84, has moved himself and his family to their new house in Naperville, Ill. He started with Dukane Corp. on August 1 and is enjoying living in the Chicago area. . . . **Kenneth W. Miller,** S.M.'82, called on August 3 to announce that he and the family would be moving to Connecticut at the end of August. He has taken a promotion at Duracell and is now product development manager for speciality batteries in Tarrytown, N.Y. His wife, Joan, has completed her first year of an executive M.B.A. program and will be looking for a similar program where she can continue her studies. . . . **Jerome P. Sutton,** S.M.'83, called at the end of July while spending a day at Mitre Corp. on business. His position at Wright-Patterson Air Force Base has expanded, and now he is heading a group doing advance planning for the B1 project. He has been in telephone contact with **Carol M. Lemlein,** S.M.'83, and reports that she is still working increasingly hard at Teradyne.

Wilbur (Bill) Vanderslice, S.M.'83, moved (in July) to a new condominium right on the water in Cos Cob, Conn. He and his wife, Charlene did some sailing this summer in their new boat, and he described one rather scary trip from Falmouth, Mass., where they had to navigate in thick fog. Sounds like a tough life! . . . **Shang-zhi Wu,** S.M.'84, will start at the World Bank, Wash., D.C., next January. In the meantime, his baby returned from his parents in China this summer, and he and his wife are still

here in Cambridge while Wu completes his Ph.D. in mechanical engineering at M.I.T. .—Jane Morse, Program Manager, M.I.T., Room E52-125, Cambridge, MA 02139

XVI

Aeronautics and Astronautics

Charles Stark Draper, Sc.D.'26, has added another to his long list of prizes and tributes—an honorary doctor of science from Boston University, awarded (in Dr. Draper's absence because of illness) last May 13. . . . **Charles A. Huebner,** S.M.'60, is currently vice-president of planning and business development at Transway International Corp., New York City. He formerly held a similar position with U.S. Industries, Inc. . . . **Peter B. Rhines,** S.M.'64, theoretical oceanographer who has been senior scientist at Woods Hole Oceanographic Institution, has taken a faculty post as professor of oceanography at The University of Washington, Seattle.

The following deaths have been reported to the Alumni Association, with no further details available: **Abraham L. Baird,** S.M.'39, from Santa Monica, Calif., on October 31, 1983; **Frederick J. Cole,** '41, of Pawleys Island, S.C., on February 25, 1984; and **Ritchie G. Simmers,** Sc.D.'38, of Wellington, New Zealand, on April 22, 1984.

XVII

Political Science

Technologies of Freedom, a study of problems of free speech in an electronic age by the late Professor **Ithiel D. Pool,** is winner of the American Political Science Association's 1984 Gladys M. Kammerer Award, for the best book published on U.S. national policy during the year. Professor Pool died on March 11, 1984, a few weeks after publication of the book by the Harvard University Press.

XVIII

Mathematics

Professor **Kenneth M. Hoffman,** in the department at M.I.T., has been appointed executive secretary for national affairs for the Joint Policy Board for Mathematics, to continue recent efforts to improve communications between the federal government and the mathematical sciences community. . . . **Jan List Boal,** Ph.D.'59, professor of mathematics and computer science at Georgia State University, Atlanta, writes to correct an earlier report in these columns (*April 1984*): he is *male,* not female, and the editors apologize. Boal also notes that he is co-author of "County Agent's Problem: Or, How Long is a Short Barn?" in *The Mathematics Teacher* (April 1984, Vol. 77, No. 4). . . . Professor **Harold Abelson,** Ph.D.'73, Professor **Gerald Jay Sussman,** Ph.D.'73, and **Julie (Mazel) Sussman,** '80 are authors of *Structure and Interpretation of Computer Programs,* published by the M.I.T. Press. Abelson and Sussman are members of the computer science faculty in Course VI at M.I.T., and this is a textbook for 6.001, M.I.T.'s introductory computer science course. It is the first book in the M.I.T. Electrical Engineering and Computer Science series.

William H. Barker, Ph.D.'73, associate professor in the Department of Mathematics at Bowdoin College, Brunswick, Maine, is co-author of *The Calculus Companion,* published in two volumes by John Wiley & Sons, Inc. The text is designed "to give the students a deeper understanding of the concepts and computational processes of calculus." . . . **John A. Nohel,** Ph.D.'53, has been professor of mathematics at the University of Wisconsin, Madison, since 1961 and has been serving as director of the Mathematics Research Center since 1979.

Professor Jerome C. Hunsaker (chairman) and three of his colleagues at the December 17, 1942, meeting of the National Advisory Committee on Aeronautics: (left to right) Vannevar Bush, '16, then president of the Carnegie Institution of Washington; aviation pioneer Orville Wright; and G. W. Lewis, then NACA's director of aeronautical research. (Photo: M.I.T. Museum)

Jerome C. Hunsaker, 1886-1984
Pioneer in Aeronautics

Professor Emeritus Jerome C. Hunsaker, Sc.D.'16, the founding head of M.I.T.'s Department of Aeronautical Engineering who was a major figure in world aviation and at the Institute for over 50 years, died at his home in Louisburg Square, Boston, on September 10. He was 98.

James H. Doolittle, Sc.D.'24, the Air Force general who went on to succeed Hunsaker as chairman of the National Advisory Committee for Aeronautics (of which today's NASA is the direct descendent), described Hunsaker as "one of the great people of our era," and similar tributes came from countless others in aeronautics and education.

In his remarkable 50-year career, Hunsaker built the first effective wind tunnel in the U.S. (as an M.I.T. graduate student); gave M.I.T.'s first courses in aeronautics, at a time when, as he later said, "it was not possible to teach the principles of aeronautical engineering because none of us knew them"; directed all naval aircraft design, construction, and procurement in World War I; built the first American rigid airship, the *Shenandoah*; served for 15 years as Chairman of the NACA during which time the Ames and Lewis Laboratories were developed and the foundations were put in place for what ultimately became NASA; was the first president of the Institute of the Aeronautical Sciences (now the American Institute of Aeronautics and Astronautics); and was the teacher and role model for countless M.I.T. students and teachers, including Donald W. Douglas and Charles S. Draper.

Born in Creston, Iowa, in 1886, Hunsaker was sent to M.I.T. by the Navy following his graduation in 1908 from the U.S. Naval Academy. His Institute teaching career began while he was a naval officer and graduate student, then was interrupted for World War I service and several years in industry. Hunsaker returned to the Institute to head the Department of Mechanical Engineering in 1933; he soon took charge of the course in aeronautical engineering and became head of that department when it was established in 1939. He retired in 1952 but continued to take an active role in M.I.T. affairs for another 20 years.

Widely honored, Hunsaker held the Presidential Medal of Merit, the French Legion of Honor, the Wright Brothers Memorial Trophy, the Daniel Guggenheim Medal, the Godfrey L. Cabot Trophy, the Langley Medal, the Gold Medal of the Royal Aeronautical Society (of which he was honorary fellow), the Navy Award for Distinguished Public Service, the Presidential Citation for service of NASA, and the Franklin Medal.

Walter H. Gale, 1907-1984

Professor Emeritus Walter H. Gale, '29, who was a member of the faculty in aeronautical engineering from 1946 to 1958 and continued as administrative associate until 1964, died at his home in Melvin Village, N.H., on July 11; he was 77.

The strong industrial background gained after graduation with a master's degree from M.I.T. in 1930 led Gale to be a champion of close ties with industry when he returned to the faculty in 1946 after World War II service in the Navy. To capitalize on this interest he was asked to design a new program of summer courses at M.I.T. for representatives of industry, government, and other institutions and was director of the Summer Session from 1949 to 1951. Later he served as secretary of the Institute and in this period made important contributions to the Industrial Liasion Program.

Earl B. Millard, 1888-1984

Professor Emeritus Earl B. Millard, who taught chemistry at M.I.T. for just under 40 years while at the same time holding important responsibilities in research administration, died on July 11 at his retirement home in Santa Barbara, Calif. He was 96.

Professor Millard studied chemistry at the Universities of Colorado (B.A. 1910), Wisconsin (M.A. 1911), and Illinois (Ph.D. 1914) and came immediately to M.I.T. as instructor—and also to serve as assistant director of the Division of Industrial Cooperation (now the Office of Sponsored Programs). He was professor of physical chemistry from 1935 to 1953.

John Cook, 1919-1984

John Cook, organist, conductor, and composer who was Institute organist and lecturer in the Music Section of the Department of Humanities from 1965 to 1982, died at his home in Georgetown, Mass. on August 12 following a long illness. He was 65.

Cook, a native of England, began his musical career as a student at the Royal College of Music in London, where he was conductor of the orchestra of the

Old Vic Theater. Later—before coming to the U.S.—he was organist-choirmaster at Holy Trinity Church, Stratford-on-Avon, and St. Paul's Cathedral, London, Ontario, serving concurrently as music director of the Stratford Ontario Shakespeare Festival. In Boston after 1961, Cook was music director of the Church of the Advent before assuming his M.I.T. duties.

Cook's compositions include choral anthems, mass settings, and other organ works as well as incidental music and settings for several Shakespeare plays.

Deceased

Bion A. Bowman, '09; August 5, 1984; c/o Evan Turner, 3071 N Park Blvd., Cleveland, Ohio.
Jerome C. Hunsaker, '12; September 10, 1984; 10 Louisburg Sq., Boston, Mass.
Joseph W. Barnwell, '15; September 7, 1984; 2206 Terrace Way, Columbia, S.C.
Sherwood H. Taber, '18; 1984; 824 Doan Dr., Burbank, Calif.
Donald F. Bixler, '22; July 8, 1984; Cathedral Village H508, 600 E Cathedral Blvd., Philadelphia, Penn.
Philip S. Wilder, '23; April 12, 1984; Thornwood Draper Dr., Oneonta, N.Y.
Percy D. Fuller, '24; January 23, 1984; RR 2 Box 86 K-5, c/o Avon Lane, Waretown, N.J.
Norman L. Marden, '24; July 11, 1984; 10 Hatherly Rd., Wollaston, Mass.
Charles H. Bowles, '25; June 26, 1984; PO Box 186, Center Harbor, N.H.
Willard F. McCornack, '26; July 20, 1984; 6905 Lois Dr., Springfield, Va.
Arthur J. Connell, '27; August 26, 1984; 53 Yale St., Winchester, Mass.
William G. Payne, '27; June 23, 1984; 234 Ridge Ave., c/o J. Larimer, Troy, Ohio.
Thomas E. Garrard, '28; August 23, 1984; PO Box 729, Macalester, Okla.
Ben L. Bassinor, '30; May 1984; 44 Summer St., Dover, N.H.
John B. Osborne, '30; April 1984; 489 Fairmount Ave., Chatham, N.J.
Susan M. Tully, '30; 1983; 30 Spring St., Yarmouth, Maine.
Grant S. Willey, '30; November 11, 1984; c/o Aqna Bach Home, 1422 W Liberty, Ann Arbor, Mich.
Robert J. Fleming, Jr., '31; July 14, 1984; 315 Waverly Apt. 1, Menlo Park, Calif.
Frederic W. Nordsiek, '31; April 4, 1984; 500 Umstead Dr. 308B, Chapel Hill, N.C.
Harold M. Wilson, '31; August 19, 1984; 96 Long Hill Rd., Bolton, Mass.
Paul W. Lefevre, '33; July 17, 1984; 48 Western Ave., Brattleboro, Vt.
Albert M. Patterson, '33; July 18, 1984; 953 Ridge Rd., Lewiston, N.Y.
Robert A. O'Brien, '34; April 27, 1984; PO Box 1094, 10 Pearl Ave., Onset, Mass.
David D. Terwilliger, '35; August 27, 1984; 21 Rainbow Pond Dr., Walpole, Mass.
David L. Sargent, '38; August 20, 1984; 10 Auburn Rd., Wellesley, Mass.
William B. Dubois, '41; August 14, 1984; RFD 1, Plattsmouth, Neb.
Maria Lynde Gately, '41; July 10, 1984; 19 Pines Rd., Revere, Mass.
Edward C. Hobaica, '48; June 28, 1984; 13 Heath St., Mystic, Conn.
Hugh Muir, '53; June 26, 1984; 183 Deepwater Rd., Castle Cove, Australia.
James A. Lisnyk, '64; August 1, 1984; 5902 Benfield Dr., Alexandria, Va.
Richard D. Auster, '69; April 23, 1984; 1206 E Linden, Tucson, Ariz.
Stephen A. Andrews, '86; July 22, 1984; 1006 Cherokee Rd., Scotia, N.Y.
Brian C. McCarroll, '87; August 24, 1984; 44 Flower House Dr., Fairfield, Conn.

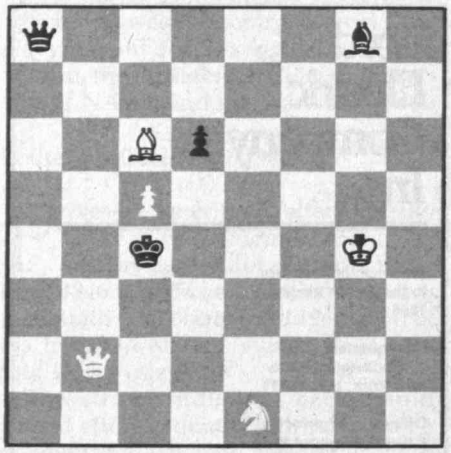
ALLAN J. GOTTLIEB

The Life Expectancy of a Moolah Dola

Phelps Meaker, '25, *Puzzle Corner*'s most faithful 83-year-old contributor, often supplements his problems and solutions with best wishes for our son David. Now he has sent David a beautiful handmade rendition of the star of David constructed out of six radial sticks and many strands of yarn connecting alternate radii. It has quickly become one of the family's prized possessions. Since I have no siblings and Alice but one, David doubled his uncle quota now that we have "adopted" Uncle Phelps. By coincidence (really), one of Mr. Meaker's problems has come to the head of the queue and appears as **N/D 4** below. Moreover, both the problem and the stick-and-yarn construction are based on triangles and hexagons.

Problems

N/D 1. We begin with a chess problem from Jack Weatherly that was inspired by our original (misprinted) version of **1983 A/S 1.** Mr. Weatherly entitles his offering "A Variation on Winthrop Leeds' Attribution to Geoffry Mott-Smith's Contribution." The problem: White, moving first, is to mate in three moves.



N/D 2. Smith D. Turner ($\int dt$) wants you to find a number that equals its own logarithm.

N/D 3. Here is a problem that appeared a few years ago in the annual M.I.T. Math Club contest:

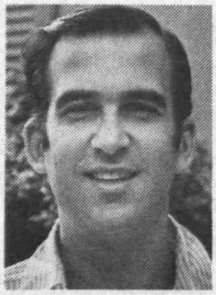
The floor lamps found in many Institute rooms pose an interesting problem. Each of these lamps has two bulbs, and each socket has a chain which when pulled will change the on/off state of only the bulb in that socket. When the lamp is on, it is difficult to determine whether one (and if so which one) or both bulbs are on. The problem is to find the shortest sequence of pulls that will turn the lamp completely off sometime during the sequence (e.g., if chains are labeled A and B, AABBAB fits the requirements, but a shorter sequence may be found). Can you generalize your solution to a lamp of three bulbs, four bulbs, etc.? Is your solution unique?

N/D 4. A geometery problem from Phelps Meaker:

A regular hexagon can be inscribed in an equilateral triangle so that its alternate sides coincide with the sides of the triangle. What is the ratio between the areas of the hexagon and the triangle?

N/D 5. Frank Rubin's money (and problem stockpile) never seem to run out:

In the country of Moolah, the national bank issues new dola bills to replace each bill that wears out or is lost or destroyed, so there is always a constant number of dolas in circulation. On January 1, the bank issued a new bill with the picture of Prince Centime replacing that of the late Queen Peseta. After one year, they found that 10/27 of the bills in circulation were the new variety. After two years, 2/3 of the bills; after three years 8/9 of the bills; and after four



ALLAN J. GOTTLIEB, '67, is associate research professor at the Courant Institute of Mathematical Sciences of New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y. 10012.

years all the bills were the new type. What is the life expectancy of a dola bill?

Speed Department

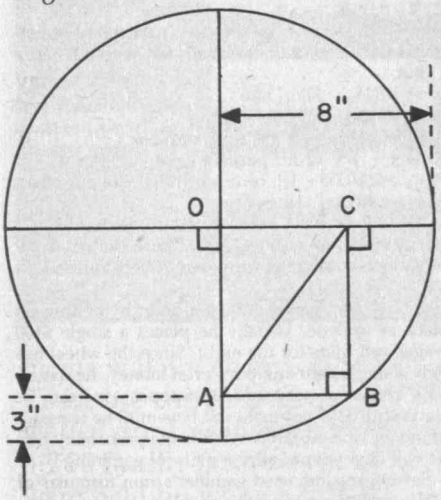
SD 1. A bridge quickie from Doug Van Patter:

North (Dummy):
♠ 9 6 2
♥ K 4 3
♦ A 8
♣ A 9 7 6 2

East (You):
♠ K Q J 8 3
♥ J
♦ K 10 5
♣ K 8 4 3

You (East) are defending against a six-heart contract in a high-stakes game. Your partner leads the ♣5, which is taken by the ♣A. Declarer plays three rounds of trumps, then leads the ♣Q to your ♣K. Your partner shows out. Can you find a way to save a lot of money?

SD 2. Chris Wee wants you to find the length of AC:



Solutions

JUL 1. You are South and open one no-trump. Your partner falls in love with her hand, transfers in spades, and puts you in a highly optimistic six-spade contract. Can you justify her faith in your declarer play?

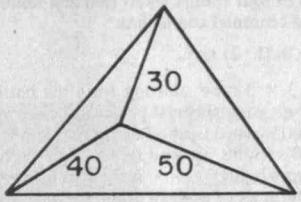
	♠ J 10 9 8 6 3 ♥ A J 5 ♦ K ♣ A 9 3	
♠ Q 4 ♥ K 7 3 ♦ 10 7 6 4 ♣ Q J 10 7		♠ 7 5 2 ♥ Q 9 4 2 ♦ Q 5 3 2 ♣ 5 4
	♠ A K ♥ 10 8 6 ♦ A J 9 8 ♣ K 8 6 2	

Opening lead: ♣Q.

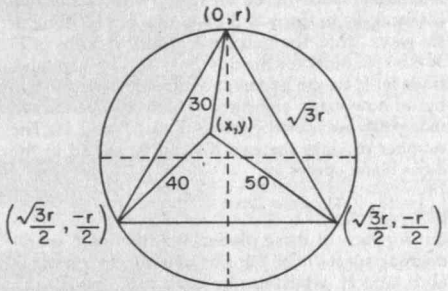
Rev. Joseph Hahn sent us the following solution: Win the club in dummy. Play the ♦K. Small trump to hand. Ruff a small diamond. Another small trump to hand. Ruff another diamond. Small club to ♣K. Play ♦A, throwing off the last club. Lead small heart to finesse West. If he covers, play ♥A, then ♥J, and the rest are yours. If he ducks, play ♥J. East must lead a heart through your 10-8 to pick up West's ♥K. (If he plays small, put in the 8; if he plays the ♥9, put in the ♥10.)

Also solved by Joseph Lambert, Carl Estes, G. Zartarian, Matthew Fountain, Richard Hess, Winslow Hartford, John Bobbit, and the proposer, Doug Van Patter.

JUL 2. Given an equilateral triangle with the indicated lines and lengths, determine the length of a side.



Norman Spencer remarks that he has seen this problem many times in the past 30 years including once in the 1979 June/July issue of *Puzzle Corner* (oops). The following solution is from Howard Stern:



First circumscribe the triangle and orient it as shown above. The circle has radius r and the side of the triangle, by simple geometry, has length $\sqrt{3}r$. The coordinates of the interior point where the three lines meet are (x,y). By the Pythagorean Theorem we have:

$x^2 + (y - r)^2 = 30^2$ (1)
$(x - \sqrt{3}r/2)^2 + (y + r/2)^2 = 50^2$ (2)
$(x + \sqrt{3}r/2)^2 + (y + r/2)^2 = 40^2$ (3)

Expanding, then simplifying the above gives:

$x^2 + y^2 + r^2 - 2yr = 900$ (1)
$x^2 + y^2 + r^2 + yr - \sqrt{3}xr = 2500$ (2)
$x^2 + y^2 + r^2 + yr + + \sqrt{3}xr = 1600$ (3)

Subtract (3) from (2) to get:
$x = -450/(\sqrt{3}r)$.
Add (2) and (3) and subtract twice (1) to get:
$y = 1150/(3r)$.
Substitute these results into (1) to get an equation in r:
$9r^4 - 15000r^2 + 1930000 = 0$.
Using the quadratic formula to solve for r^2, we get:
$r^2 = 2500/3 + 400\sqrt{3}$.
The side of the equilateral triangle is $\sqrt{3}r$ or:
$\sqrt{3}[2500/3 + 400\sqrt{3}]^{1/2} = 67.66432567$.
In addition, the Law of Cosines can be used to prove that the angle formed by the 30 and 40 lines is exactly 150°.

Also solved by Matthew Fountain, Winslow Hartford, Richard Hess, Judith Longyear, A.C. Lawson, David Parker, Richard Heldenfels, Harry Zaremba, Roy Boyle, Avi Ornstein, Mel Garelick, Norman Wickstrand, Clarence Cantor, Everett Leedy, Steve Feldman, Henry Lieberman, Peter Card, Frank Carbin, F.C. Jelen, David Evans, Joe Lovington, Eugene Sard, and Farrel Powsner who noticed that a similar problem was used by the New York City Interscholastic Mathematics League.

JUL 3. If a chess cube is placed in the corner square of a 3 × 3 chessboard, there are six distinct shortest paths (i.e., combinations of vertical and horizontal moves which do not backtrack) to the diagonally opposite corner. How many distinct shortest paths exist from a corner cell of a 3 × 3 × 3 cube to the cell opposite along a space diagonal, assuming movement parallel to the three axes? How about in a 3 × 3 × 3 × 3 hypercube?

Charles Sutton makes it look easy:
Assuming the shortest paths in the 3 × 3 chessboard are from the lower left to the upper right corner, the six paths can be designated RRUU,

RURU, RUUR, URRU, URUR, and UURR, where R and U denoted unit moves to the right and up, respectively. The number of such paths is clearly the number of four-letter "words" that can be formed using two R's and two U's. If the two R's are first placed in the four blank spaces, - - - -, the number of ways of doing this is the number of combinations of four things taken two at a time, which is just the binomial coefficient:

$$\binom{4}{2} = (4 \cdot 3)/(1 \cdot 2) = 6.$$

In a 3 × 3 × 3 cube, starting from the bottom left front corner, each shortest path can be represented by a six-letter word formed using two R's, two U's, and two B's (right, up, and back). We now have six blank spaces to fill, - - - - - -. If the two R's are placed first, the number of ways of doing this is the number of combinations of six things taken two at a time:

$$\binom{6}{2} = (6 \cdot 5)/(1 \cdot 2) = 15.$$

But for each of these placements, there are four remaining spaces to be filled by two U's and two B's, and, as in the 3 × 3 case, this can be done in six ways. Thus the number of shortest paths is 15 × 6 = 90. Now for the 3 × 3 × 3 × 3 hypercube. If we let H be the hyperspace direction, we have to figure how many eight-letter words can be formed using two each of the letters R, U, B and H. The number of ways the two R's can be placed in the eight blank spaces is:

$$\binom{8}{2} = (8 \cdot 7)/(1 \cdot 2) = 28.$$

But for each of these placements, there are six remaining spaces to be filled by two each of the letters U, B, and H, which can be done in 90 ways, as in the 3 × 3 × 3 case. Thus the number of shortest paths in the 3 × 3 × 3 × 3 hypercube is (28)(90) = 2520. Continuing this process, it is easy to see that the number of shortest paths in an n-dimensional cube, three units on a side, will be:

$$\binom{2n}{2}\binom{2n-2}{2}\binom{2n-4}{2} \cdots \binom{4}{2},$$

which can be simplified to $(2n)!/2^n$. And, using the same procedure, the number of shortest paths in an n-dimensional cube which is r units on a side turns out to be

$[n(r-1)!/[(r-1)!]^n$.

Also solved by Matthew Fountain, John Bobbit, Richard Hess, Dick Wingerson, and the proposer, David Evans.

JUL 4. Show that it is physically impossible to "load" a pair of ordinary dice such that each of the eleven possible rolls is equally likely to occur. (Generalize to the other four regular polyhedra—e.g., the possible rolls of a pair of regular dodecahedra).

Oren Cheyette informs me that by solving **JUL 4** (the solution we are reprinting below) and **JUL 5** he has extended his anticipated Ph.D. completion date by one day. Here is one of those costly solutions:

For a pair of k-sided dice there are 2k − 1 possible rolls, from 2 to 2k. For "uniform" dice, the probability of each result must be 1/(2k − 1). Denote the probability of rolling an n on the first die p_n and on the second die q_n, and the probability of a total m on the two dice by P_m. Then

$P_2 = p_1q_1 = P_{2k} = p_kq_k = 1/(2k-1)$

while

$P_{k+1} = p_1q_k + p_kq_1 \ldots = 1/(2k-1)$

where . . . denotes the positive probability of getting a (k + 1) some way other that with a k and a 1. But

$q_1 = [1/(2k-1)]/p_1$ and

$q_k = [1/(2k-1)]/p_k$, and thus

$p_{k+1} = [1/(2k-1)][p_1/p_k + p_k/p_1] + \ldots$

Now $x + 1/x > 2$ for positive x, so

$P_{k+1} > 2[1/(2k-1)]$, contradicting the requirement $P_{k+1} = 1/(2k-1)$.

Also solved by Winslow Hartford, Richard Hess, Henry Lieberman, Peter Card, Pierre Heftler, Tony Trojanowski, and the proposer, Albert Mullin.

JUL 5. A man gambles $100 a night by betting on black at roulette. Usually he places a single $100 wager and quits for the night. Since the wheel has only a single zero and pays even money, he has an 18/37 chance of winning $100. Suppose, instead, he starts with $100 but makes $1 bets until he runs out of money or is up $100. What is the probability that he will be a winner after a night of gambling?

Several readers used gambler's ruin formulas or Markov chains to solve this problem. I selected Matthew Fountain's solution since he simply established a clearly valid recurrence and plugged in the natural boundary conditions. However, Mr. Fountain doubts that the better very often completes his betting in one night. If he loses at the rate of $1 per 37 spins, he must average about 3700 plays to lose $100. This would require more than five spins per minute for twelve hours. Incidentally, Winslow Hartford believes somebody should tell Mr. Jones that it is at Monte Carlo that there is only one zero. Las Vegas pays for the floor shows with an extra zero, and the odds are 18/38.

Also solved by Frank Carbin, F.C. Jelen, David Evans, Steve Feldman, Oren Cheyette, Richard Hess, John Prussing, Ronald Raines, and the proposer, Richard Jones.

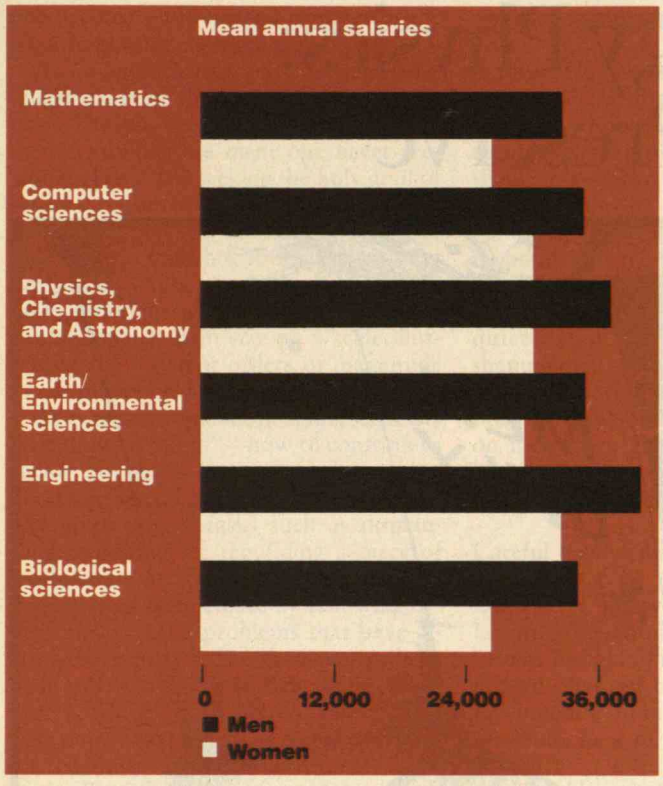
Better Late Than Never

M/J 1. Ronald Raines has responded.

Proposers' Solutions to Speed Problems

SD 1. Put the ♦K on the table. This may lose a diamond trick but guarantees that declarer cannot pitch losers on dummy's last two clubs. (Declarer's ♣J is still blocking the suit. Declarer's club holding was originally Q J 10.)

SD2. 13 inches.



ments will not change much for another generation. There are currently about 171 Ph.D.-granting physics departments in this country, with a total of almost 4,200 faculty positions at all levels. Only 79 of these were held by women in 1982, according to *Physics Today*. And women held only 188 of 4,400 faculty posts in chemistry departments that grant doctorates in 1983, according to the Women Chemists' Committee of the American Chemical Society. At the present rates of hiring and promoting women, there should be a few more permanent women faculty in another decade, but no significant change can be expected for another 25 years.

The situation in industry is not much better, although it has improved from a dismal level in the 1970s. Based on the available pool of doctorate recipients, women Ph.D.s remain underrepresented in industrial research positions by about 50 percent, according to a survey by the National Academy of Sciences. Those who do obtain employment are only about half as likely as men to advance to management positions. No explanations have been offered for such disparities. Predictably, however, these inequalities result in significant differences in compensation. The median salaries of male scientists exceed those of their female colleagues by about $4,000 to $8,000, depending on the field. Among scientists in industry, men and women Ph.Ds with 15 or more years of work experience differ by as much as $10,000 in annual pay.

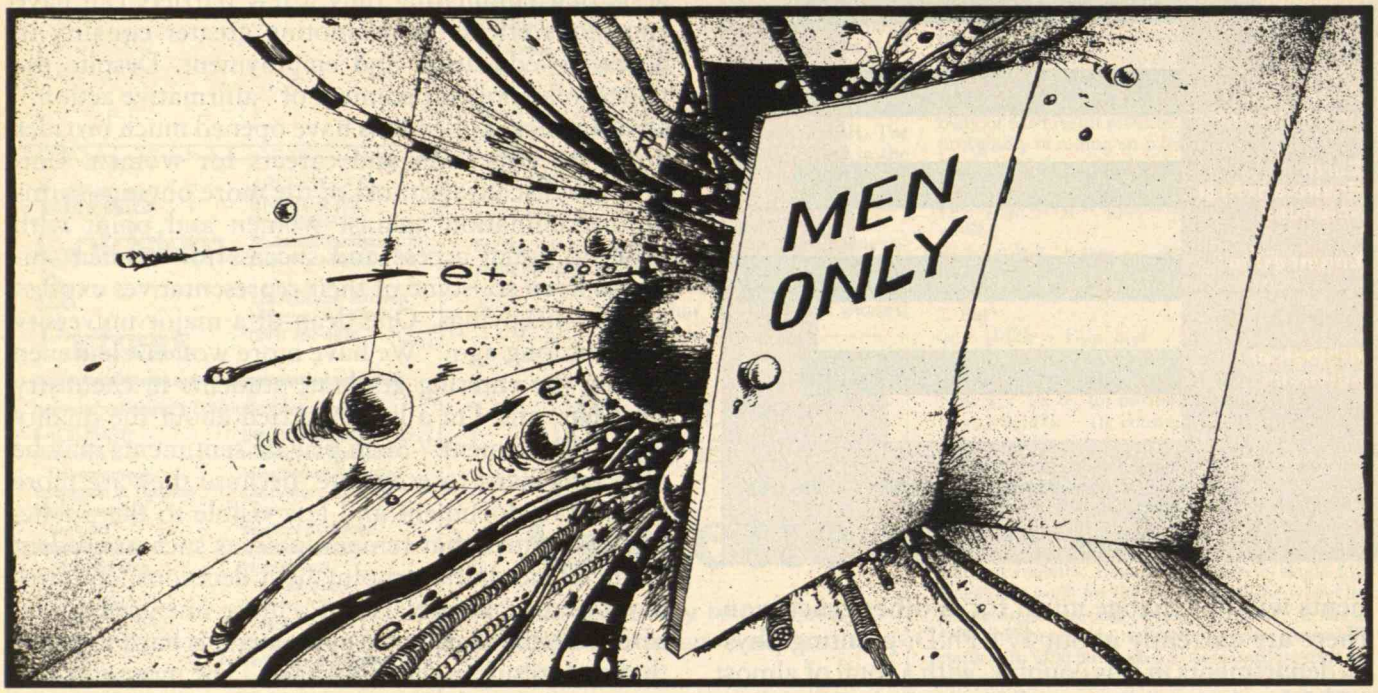
The experience of the last 15 years strongly suggests that eliminating only a few barriers can have enormous effects in promoting greater equality in access to education and employment. Despite the widespread nonenforcement of "affirmative action," laws against explicit bias have opened much broader access to education and careers for women. Universities discourage most of the more obvious forms of discrimination against women and point with pride to equal access and success for women students. Even so, some of their representatives express private misgivings. One dean of a major university said not long ago: "We have more women than men among the entering graduate students in chemistry this year, and I'm a little worried about the quality of the department." Such private sentiments may be especially hard to eradicate, because they are more difficult to document and less visible to the public. The disparities that remain in areas such as student financial aid, initial employment decisions, and promotion and pay are also of a more fine-grained nature. Taken one instance at a time, it is hard to prove that they result in discrimination. The most effective way to deal with them is probably not by external intervention but through the leadership of administrators and senior faculty. M.I.T. took this approach more than a decade ago and has had considerable success in recruiting women as both students and faculty, even in fields that have traditionally "had no women."

Despite the many barriers that still exist, women form a significant and increasing proportion of the most recently trained cadre of scientists and engineers. These are the people at the cutting edge of science and technology—those who will help shape the world of each generation. Enlightened self-interest suggests that we all learn to make the most of that future.

LILLI S. HORNIG is executive director of Higher Education Resource Services (HERS) at Wellesley College. She holds a Ph.D. in chemistry from Harvard University and has taught at Brown University and Trinity College in Washington, D.C., where she chaired the chemistry department. She has also chaired the National Academy of Sciences' Committee on the Education and Employment of Women in Science and Engineering, and has served as a member of the National Science Foundation's Committee on Equal Opportunity in Science and Technology.

WOMEN IN TECHNOLOGY

High-Energy Physics: A Male Preserve



BY SHARON TRAWEEK

As an anthropologist, I study "communities" of people in an effort to understand their values and "common sense" view of the world, and how that perspective shapes their everyday practices. For the past 10 years, I have been observing a particularly tight-knit community: high-energy physicists. This community includes the cream of the scientific crop—a cluster of researchers worldwide who command enormous prestige and power within the larger scientific community.

The goal of these physicists is to understand the fundamental forces of nature by examining how the basic constituents of matter—subatomic particles—interact. Their research is conducted using a few large and very expensive machines called accelerators, in which certain particles are accelerated to very high energies and forced to collide with other particles. Detectors are used to examine the debris from these collisions, and the data are analyzed to confirm or reject theories about the underlying laws of nature. Although this undertaking is extremely expensive, the community of high-energy physicists has been very successful in obtaining the funds needed to carry it out.

This community is as exclusive as it is powerful. Of the 800 to 1,000 active high-energy physicists in the world, only 300 to 400 are considered part of a "core" group that is particularly influential. Women constitute only 3 percent of the larger community, and only a handful are in the core group. After extensively observing and interviewing male and female physicists at three national laboratories and 14 universities in the United States, Japan, Switzerland, and Germany, I have found some clues to the gender gap in high-energy physics.

What I have observed is that the traits required for gaining entry into this exclusive community—aggressive individualism, haughty self-confidence, and a sharp competitive edge—are traits typically defined as masculine by our society. As one long-term observer remarked, "Only blunt, bright bastards make it in this business." At every stage of preparation for a career in high-energy physics, women are discouraged from successful participation because the models they are expected to emulate are so thoroughly masculine—at least according to our cultural stereotypes.

High-energy physicists must complete three stages of education—undergraduate school, graduate training, and postdoctoral work, the last of which usually involves an appointment as a research associate. Only after completing these stages—which last about 15 years—does

SHARON TRAWEEK is an assistant professor in the Department of Anthropology and Archeology and the Program in Science, Technology, and Society at M.I.T. She has recently completed Buying Time and Taking Space: The Culture of the Particle-Physics Community.

ILLUSTRATION: EUGENE YELCHIN

High-energy physics remains a male "club" because the traits required for success are so strongly identified as masculine.

one become a full-fledged member of the particle-physics community.

As undergraduates, physics majors are taught to revere the heroes of the scientific past. The physicists they learn about in their textbooks are men; one never sees women physicists seeking the holy grail of rational objective truth. A single textbook does depict women, but only in cartoons. One shows a foolish schoolmarm teaching her students silly ideas; another shows a nude pinup of a woman, ostensibly to demonstrate human size on a scale illustrating the different orders of magnitude in the universe.

As graduate students, fledgling scientists learn how to "fit in"—how to conform to senior physicists' notion of what makes good scientists. For instance, they are usually given menial tasks such as dismantling, repairing, or rebuilding a piece of malfunctioning equipment; here, students display their competence by following orders and tackling problems that have already been solved. The graduate students hear stories about scientists doing whatever is necessary to obtain, record, and save data. One such story concerns a bubble chamber at the now-defunct Cambridge Electron Accelerator (CEA). As this story goes, a propane tank exploded there one night, practically blowing the students out of the lab; they could have been killed. One student realized he was going to lose the data for his thesis and ran back in to get the information. A second explosion blew him out the door again, data in hand.

Also during the graduate stage, students begin to learn from their faculty advisors what is meant by "good taste," "good judgment," and "creative work" in physics. Again they hear stories about dogged commitment and stunning success, tales that are often told over beer at local bars where women rarely feel comfortable. The graduate students are learning to "live and feel" physics, and a close relationship with their faculty advisors is crucial. It's easier for professors to see themselves in younger members of the same sex, and that may explain why older men in positions of authority feel more comfortable with younger men. Yet women students cannot expect to work with senior women faculty members in physics since there are so few.

The postdoctoral period concludes the long apprenticeship and can itself last as long as six years. During this period, the initiates are evaluated to determine who will be invited to join the "core" community of high-energy physicists, who will join peripheral groups, and who will leave the field. In particular, the senior experimentalists scan the research associates (RAs) to see who is "charismatic." They determine this by watching how the RAs handle conversations; the preferred style is confident, aggressive, and even abrasive if one student suspects that another's ideas are incorrect. The group leaders also quietly look for researchers intent on shaping their own reputations rather than simply achieving the goals established by others. Successful initiates must strike out on their own, although this means disobeying orders and finding a new project or task that the group has not requested.

Careful Insubordination

One RA I interviewed at the Stanford Linear Accelerator (SLAC) said he knew he was not going to be accepted as a full-fledged physicist because he had failed at this juncture. In his first year as a research associate, he said, "charm" became fashionable. Charm, along with "color," "beauty," "top," and "bottom," are arbitrarily named differences among "quarks," a class of subatomic paticles. But out of loyalty and commitment, the RA stuck with his assigned task instead of pursuing "charm." He now feels this decision cost him his career in high-energy physics.

The social training of most women teaches us to be too concerned about getting along well with other people to display the degree of social eccentricity, disdain for others, and careful insubordination required at this stage.

During this postdoctoral period, physicists also learn the art of persuasion: how to convince others of the significance of their own work. These skills are further honed once scientists gain entry to the high-energy physics community itself. For instance, I have observed that physicists are always telling stories about how good their work is and how inadequate the work of others is. One physicist at SLAC told me that "there is no one in-house at Fermilab [the Fermi National Accelerator Laboratory near Chicago] who can tie his shoes experimentally." Another physicist who regularly conducts experiments at Fermilab said that some well-known experimentalists are consistently wrong. He did mention that he had found one who is consistently right: a man who "never has an original idea" but who specializes in "shooting down spectacular experiments." Several other physicists also told me stories about the same man's supposedly egocentric, authoritarian manner and his mundane physics. I should add that this individual has won a Nobel Prize.

One senior woman high-energy physicist is seen by the men as displaying this skill of promoting her own work and effectively denouncing the work of others. While her skill is widely admired, she is also referred to with the vulgar epithets reserved for women who wield power in the world of men. This clearly constitutes a double bind for the younger women who might otherwise see her as a role model.

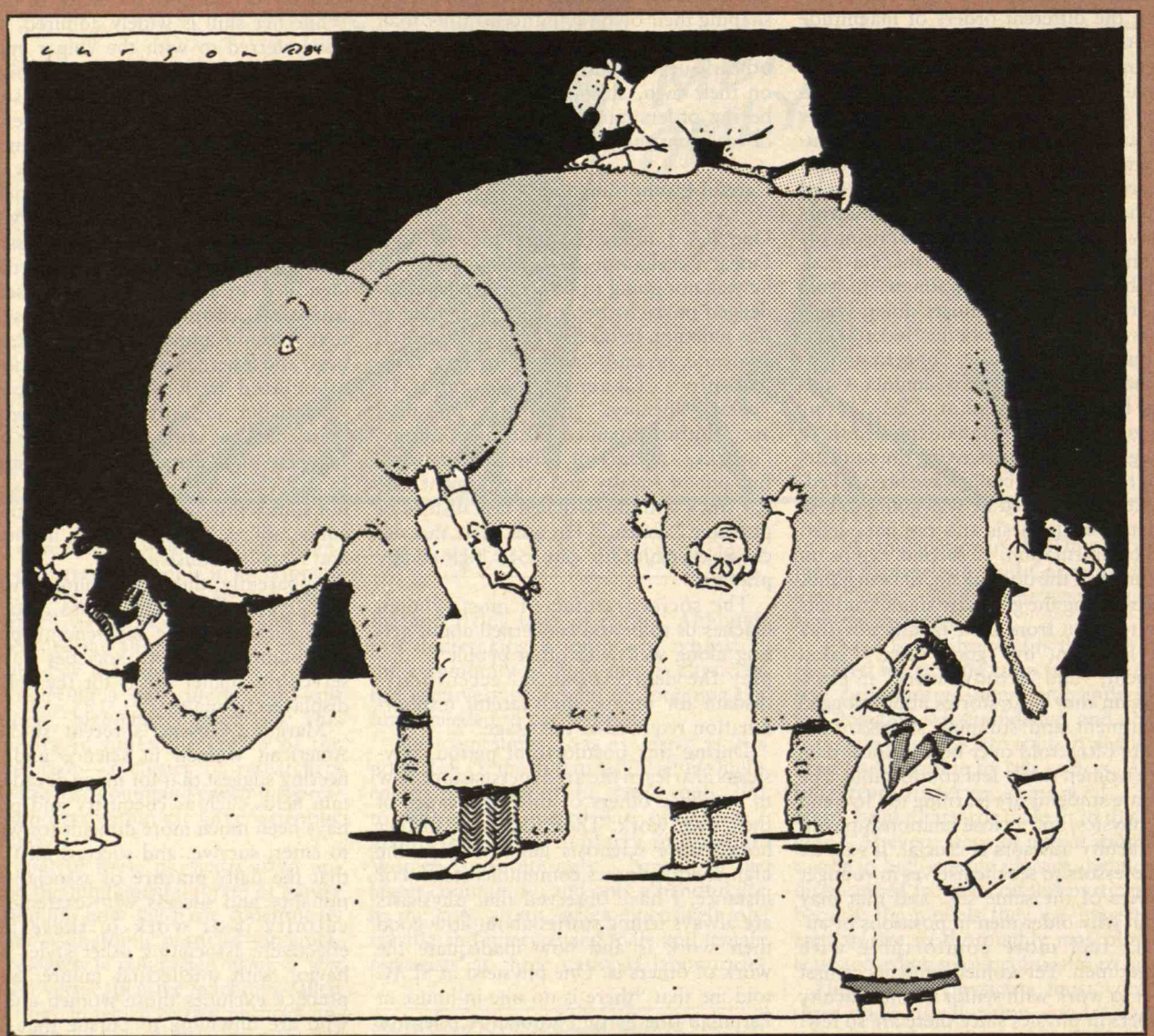
I am not suggesting here that only males can be successful high-energy physicists. I *am* claiming that certain personality traits are clearly associated with success, and that these characteristics are strongly identified in our culture as masculine. Ironically, recent studies in Japan suggest that extreme individualism, aggressiveness, and a fierce sense of competition are associated with successful Japanese women but not with men. Furthermore, these traits are not highly regarded by the Japanese high-energy physics community. In fact, women physicists there are seen as not sufficiently schooled in the more masculine abilities of consulting, negotiating and reaching consensus.

Apparently, there is nothing consistent cross-culturally in the virtues associated with success in the high-energy physics community. Yet both societies have reserved the higher status for the behavior displayed by males.

Margaret Rossiter's recent studies of American women in science and engineering suggest that for many decades certain fields such as chemistry and physics have been much more difficult for women to enter, survive, and succeed in. I claim that the daily practice of associating rationality and success with extreme masculinity is at work in these fields, effectively associating other styles of behavior with intellectual failure. Such a practice excludes those women and men who are unwilling to pursue that ethos. This will change only when senior members of these research communities recognize that diversity and flexibility could be their greatest intellectual resources in exploring the most difficult questions. □

Women and Basic Research: Respecting the Unexpected

BY EVELYN FOX KELLER



FEMINIST scholars have called attention to the many ways our conception of science is tied up with our conception of masculinity. Modern science, they argue, is based on a division of emotional and intellectual labor in which objectivity, reason, and "mind" are cast as male and subjectivity, feeling, and "nature" as female. In this genderization of the world, it seems "natural" to describe science as a "marriage" between mind and nature—a marriage celebrating not so much union between mind and nature, but the radical separation of subject and object and, ultimately, the dominion of mind over nature. The result is a particular conception of science—one that seems more suited to men than to women.

But what if it were otherwise? What if men and women—and science—developed in a world free of such stereotypes? How might science constructed in a gender-free environment be different while still being recognizable as something we would agree to call science?

To think about how science might be different, it is not necessary—indeed, it is not possible—to try to imagine a radically different science. It is enough just to recognize the rich diversity that characterizes our scientific traditions. Science is not now, nor has it ever been, a monolithic entity. The variety of scientific practices and aspirations has always exceeded the bounds prescribed by any one ideology. If we want to know more about how science could be gender-free, we should examine those visions that have survived, even if only marginally, far from the ideological norm that names the scientific mind as male, nature as female, and science as the domination of mind over nature.

History offers us many examples of individual scientists whose science has expressed such alternative views. Our own time offers us an especially instructive example in the vision and practice of cytogeneticist Barbara McClintock, winner of the 1983 Nobel Prize in Physiology and Medicine. Not only does McClintock's work teach us about the possibility of difference in science; it offers us a philosophy of science that is premised on the intrinsic value of difference.

Much scientific research is based on the desire to force nature into a rigid set of laws—a concept more suited to men than women. But some scientists are pursuing a gender-free approach that respects nature in all its diversity.

For many years before McClintock won the Nobel Prize, her most important work was little understood and went largely unappreciated. In the course of her investigations of the intricacies of corn genetics in the late 1940s, she found that genetic elements can move from one chromosomal site to another, in an apparently coordinated way. McClintock saw genetic transposition as a key to the way individual organisms regulate their development, and perhaps even their survival in times of stress. But to most biologists at the time, her work and her theories seemed incomprehensible, if not heretical.

Since the early part of the century, genes had been thought of as simple units, laid out in a fixed, linear sequence that held the key to the unfolding of the organism. To most classical geneticists, it seemed unreasonable to suppose that genetic elements could spontaneously rearrange themselves; they were even more skeptical that such genetic rearrangements might play a crucial role in an organism's development. Such speculations came to seem yet more bizarre after the advent of molecular biology.

EVELYN FOX KELLER is a professor of mathematics and humanities at Northeastern University. In 1983-84, she was a visiting scholar in the Program in Science, Technology, and Society at M.I.T. This article has been excerpted from her book Reflections on Gender and Science, *which will be published by Yale University Press in 1985.*

The Central Dogma

The course of biological history was irrevocably altered in 1953 by James Watson and Francis Crick's discovery of the structure of deoxyribonucleic acid (DNA). According to Watson and Crick, genetic information is encoded in the DNA. From there it is copied onto the RNA, which is in turn used as a blueprint for making the proteins responsible for genetic traits. This scenario (Crick dubbed it the "central dogma") depicts DNA as a kind of executive governor of cellular organization, impervious to influence from subordinate agents within the cell. Although the central dogma was later somewhat modified, the essential autonomy of DNA remained unchallenged: information flowed one way, always from and never to the DNA.

During the 1950s and 1960s, the field of molecular genetics—primarily based on work with bacteria—accelerated with one dramatic discovery after the other. To most biologists, McClintock's work with corn genetics held little fascination compared with the quick returns from research on bacteria. Fewer and fewer of her colleagues had the expertise even to begin to understand her results, and McClintock worked in increasing isolation—paddling upstream against the current of scientific opinion. McClintock, of course, shared in the excitement of others' discoveries, but she did not share in the general enthusiasm for the central dogma. Her main criticism was that it claimed to explain too much. What was true of *E.coli* (the bacterium most commonly studied by molecular geneticists) was not necessarily true of the elephant.

The central dogma of molecular biology is illustrative of a widespread desire to unearth a "unified" law of nature—a set of rules that will explain everything and remain immune to revision. Such a quest has long been a guiding ambition in many branches of science, and especially physics. Theoretical physicists today are

ILLUSTRATIONS: JIM CARSON

searching for a "unified field theory" that will encompass all the fundamental forces in nature. To some observers, this quest for a unitary law of nature is itself a reflection of the general scientific ambition to dominate nature and reduce it to manageable size.

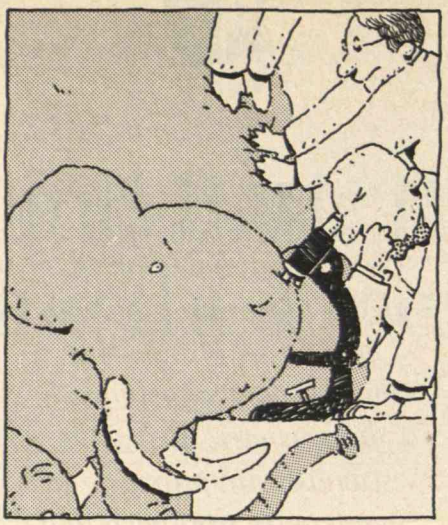
To McClintock, such a hope is, at least for biological phenomena, not only misguided but futile. "There's no such thing," she says, "as a central dogma into which everything will fit." In her own work, transposition provided direct evidence that the genetic organization of living organisms is more complex and globally interdependent than the central dogma allows. It showed that genes are neither "beads on a string" nor functionally disjointed pieces of DNA. They are units whose very function is defined by their position in the organization as a whole; indeed, they function only with respect to the environment in which they are found.

Ironically, McClintock's eventual vindication resulted from developments within molecular biology itself. Today biologists no longer doubt the significance of transposition, higher organisms and their development have once again captured scientists' interest, and almost everyone agrees that genetic organization is more complex than previously thought. But it is important not to overestimate the degree of this rapprochement. Despite the recent acclaim for McClintock's work, a major gap endures between her vision of science and that of most of her colleagues—differences that were crucial to the direction her research took in the first place.

A Feeling for the Organism

In McClintock's working philosophy, the familiar virtues of respect and humility take on a new significance. To her, nature is characterized by a complexity that vastly exceeds the capacities of the human imagination. Organisms have a life and order of their own that scientists can only begin to fathom. "They do everything we [can think of], they do it better, more efficiently, more marvelously," McClintock says. It follows, therefore, that "trying to make everything fit into a set dogma won't work."

Precisely because nature's complexity exceeds our ability to understand it, McClintock believes that scientists must "listen to the material" and "let the experiment tell you what to do." Her major criticism of most contemporary research is based on what she sees as an inadequate humility. "Much of the work is done because [scientists] want to impose an answer on it," she says. And if the material doesn't give them the answer they want, "they don't really recognize it as there, or they think it's a mistake and throw it out." For McClintock, exceptions are central because they provide the key to new understanding. Aberrant kernels of corn are signs not of disorder or lawlessness but of a larger and different system of order—one that cannot be reduced to a single law. "The important thing," she says, "is to develop the capacity to see one kernel that is different and make that difference understandable."



What is true of E. Coli is not necessarily true of the elephant.

This world view implies a special attention to difference and idiosyncracy. Each organism has an enduring uniqueness that must be respected. "No two plants are exactly alike. They're all different and as a consequence, you have to know that difference," she explains. "I don't feel I really know the story if I don't watch the plant all the way along. So I know every plant in the field. I know them intimately, and I find it a great pleasure to know them." From days, weeks, and years of patient observation comes what looks like privileged insight. The result, as one colleague described it, is an apparent ability to write the "autobiography" of every plant she works with.

Although McClintock is not speaking here of relationships with other people, the parallels are nonetheless compelling. In the relationship she describes with plants, as in human relations, respect for difference serves as a claim not only on our interest but on our capacity for empathy—in short, on the highest form of love: love that allows for intimacy without the annihilation of difference. I use the word "love" neither loosely nor sentimentally, but out of fidelity to the language McClintock herself uses to describe a form of attention, indeed a form of thought. Her vocabulary is consistently one of affection, kinship, and empathy. In speaking of her microscopic work with chromosomes, she says, "I actually felt as if I was right down there and these were my friends. . . . As you look at these things, they become part of you. And you forget yourself."

McClintock can risk suspending boundaries between subject and object without penalty precisely because, to her, science is not premised on that division. Indeed, she uses the intimacy she experiences with these organisms—intimacy born of a lifetime of attentiveness—to enhance her powers as a scientist. She is able to enlist her "feeling for the organism" in the service of impeccably rigorous research.

Empowered by her sense of kinship with the objects she studies, McClintock asks questions that are inevitably different from those that others ask about objects they see as unalterably alien. The explanations she seeks are also different. Explanations that seem satisfying about a natural world that is seen "blind, simple, and dumb"—as ontologically inferior—are likely to seem considerably less satisfying for a natural world seen as complex and inherently resourceful. To McClintock, the success of a theory is measured not by its simplicity but by its fidelity to the intricate variety of natural phenomena. The ultimate inadequacies of theories not based on this kind of respect eventually became apparent. Recent developments in genetics provide one example; our current environmental problems another. McClintock points out that "we were making assumptions [about our environment] we had no right to make. From the point of view of how the whole thing actually worked, we knew only how part of it worked."

The result, McClintock says, is that nature "is slapping us back in the face very hard."

A Gender-Free Science

It would be tempting indeed to call McClintock's vision a "feminist science." Its emphasis on intuition, on feeling, on connection and relatedness all seem to confirm our most familiar stereotypes of women. But I would argue that McClintock's vision is not that of a feminist, or a feminine, science but of a gender-free science. McClintock herself would disclaim any analysis of her work as a woman's work. To her, science is not a matter of gender, either male or female. Ideally, at least, it is a place where "the matter of gender drops away." In fact, her very commitment to science can be seen as a result of her lifelong rebellion against female stereotypes—against the stereotyping that leads us to label one domain of human experience as male and another as female.

In rejecting the traditional division of emotional and intellectual labor that has historically kept science a male preserve, McClintock was free to take a further step.

To McClintock, nature is characterized by a complexity that vastly exceeds human imagination.

She could insist on a relation between mind and nature, subject and object, characterized by an appreciation of difference more than by opposition. At the same time, she could insist on a relation with more conventional scientists that acknowledges their mutual kinship without obligating her to share all their assumptions.

I suggest that the distinctiveness of McClintock's views comes not from a feminist or feminine consciousness, but from a determination to claim science as a human rather than a male endeavor. In this, she joins all those—men and women alike—who have sought to transcend the constraints of stereotypes, wherever they arise. Both her vision and her example support efforts to reconstruct our understanding of nature in terms born out of the diverse spectrum of human experience, rather than out of the narrow spectrum our culture has labeled masculine. □

Above: Barbara McClintock, 1983 Nobel laureate in Physiology and Medicine

WOMEN WORKING

Continued from p. 38

Women Who Went Before

Confronted with the reality of a male-oriented world, how can women retain their love for science and technology and still work successfully within their fields? Janice Raymond, a medical ethicist and feminist writer, proposes in her forthcoming book, *Female Friendship*, that women find other women who have gone before them and who are going their way. In my own profession, I find that three women—Rachel Carson, Ellen Swallow, and Lois Gibbs—are responsible for the emergence of environmental science and engineering as fields of study, and for the scope and force of the American environmental movement.

Ellen Swallow, who graduated from M.I.T. in the latter part of the nineteenth century—the first woman to do so—pioneered both the science of ecology and the education of women in environmental sciences. Rachel Carson published *Silent Spring* in 1962. By 1970, as a result of Carson's eloquent and irrefutable description of the effects of pollution, the U.S. government created its first comprehensive environmental agency, the Environmental Protection Agency (EPA). Lois Gibbs, a homemaker and mother, urged her "hysterical housewife data" on the New York Public Health Department in 1978 and successfully lobbied for the removal of hundreds of families from Love Canal, possibly the worst hazardous-waste site in America. There are, then, in my field of applied science, not only women who have excelled but a tradition of women defining, directing, and critiquing science.

Finally, in the spirit of good engineering, I would like to propose some working "rules of thumb." For women and men, search for the work of women in your field. For starters, read H. J. Mozans' *Woman in Science*, Evelyn Fox Keller's *A Feeling for the Organism*, and Vivian Gornick's *Women in Science*. All three are eye-opening accounts of women's achievements in science, and they chronicle many of the impediments placed in the way of women scientists.

Again, for both women and me, know anger when you see it. Don't rush to equate women's anger with "bitchiness," defensiveness, or overemotionalism. Give women's anger the same respect you would a male colleague's. See it as toughminded, hardhitting, and uncompromising.

For men, seek out women as colleagues. Assume women have made important contributions in their fields. For women, establish the independence and power of your own work. Marie Curie worked not as a patient, tenacious research assistant but as an equal parter with Pierre Curie. After his death, her daughter, also a Nobel Prize winner, was her lifelong collaborator in research.

Finally, refuse anyone the power to deplete you of your passionate inquiry. Like Rachel Carson, find and cherish its poetry. □

Women and Computer Programming:

A Different Approach

BY SHERRY TURKLE

Although most people think programming must be done as a preplanned activity, some students, particularly girls, approach it differently. To bring women into the computer culture, we must encourage students to develop these alternative styles.

THE first formal studies are beginning to confirm what teachers have long reported: boys spend more time with computers than girls do, and boys do better in computer courses. Moreover, while boys like to learn to program, girls are more interested in "applications." They want to see the computer as practical, not as a "thing in itself." Such observations are leading to action. Some schools, for example, have started special after-school computer programs for girls so they can avoid direct competition with boys. Educational specialists have also made recommendations for how computers can be introduced in ways less "discriminatory" to women. One specialist, for instance, suggests that introductory courses should not stress computer programming, but rather applications such as word processing, which might be more likely to interest girls.

This last recommendation may open the possibility for a new kind of gender discrimination. Teachers will continue to encourage boys to program because they expect them to be good at it. But with a different set of expectations, they will encourage girls to use the computer with prepackaged programs. Thus, boys will learn how to use programming tools to make the computer their own, while girls will develop a more passive, less empowered relationship with it.

My research on children and computers suggests that some of the problems that girls experience in introductory programming have to do with the "social construction" of programming as male. Computer science is a profession largely dominated by men, and most of these men see programming as a logical, analytical activity. According to this conventional wisdom, computer programs must be developed through a structured "planner's" approach: you set your goals in advance, then you break them down into subgoals and plot your strategy through a carefully defined sequence of moves.

From my own observations in the classroom, however, I have identified a number of different ways in which children learn to program the computer. Important decisions that will affect women's relationships with the growing computer culture are being made based on a fallacy: that programming is a thing of one kind. Thus, some girls who reject programming are not rejecting the computer as such or programming as such. They are rejecting an intellectual style that has become indissociable from it in the public mind and the minds of their teachers.

"Divide and Conquer"

Jeff, a nine-year-old fourth grader, was successful in his computer work by using the conventional programming style. He was the author of the first "space-shuttle" program at his school. He devised it, as he does most other things, by making a plan—one that includes a rocket, boosters, a trip through the stars, and a landing. He conceived the program as a whole and then broke it up into manageable pieces. "I wrote out the parts on a big piece of cardboard," Jeff explains. "I saw the whole thing in my mind in just one night, and I couldn't wait to come to school to make it work." Computer scientists will recognize this top-down, "divide and conquer" strategy as "good programming style." And we all recognize in Jeff someone who conforms to the stereotype of a computer person—someone organized who approaches problems with sure intent.

But his is not the only way. Jeff's style, which I call "hard mastery," contrasts with one used by a classmate of Jeff's, Anne. Hers is a style in which the aesthetics of the graphics are more important than the elegance of the plan. It is a style in which things are not done by advance planning but through negotiation and experimentation with the machine. While hard mastery is the imposition of will over machine, "soft mastery" is more interactive. Like a painter who stands back between brush strokes, the soft master looks at the canvas—in this case the computer screen—and then decides what to do next. Hard mastery is the mastery of the engineer; soft mastery is the mastery of the artist: try this, wait for a response, try something else, let the overall shape emerge from an interaction with the medium. It is more like a conversation than a monologue.

The computer presents both hard and soft masters with an object "betwixt and between"—the computational object that appears on the screen. These computational entities stand between the world of physical objects and the world of abstract ideas, and they are taken up differently by hard and soft masters. The hard masters treat them more as abstraction, somewhat like Newtonian particles; the soft masters treat them more as dabs of paint, building blocks, cardboard cutouts. You can find examples of hard and soft mastery among both boys and girls. But I have found that girls tend to be soft masters, while the hard masters are overwhelmingly male.

In the eyes of a true hard-master programmer like Jeff, Anne, also nine, is an enigma. On the one hand, she hardly seems serious about the computer. Her enthusiasm depends on achieving visual and conversational effects, and she doesn't seem to care whether she gets them with what Jeff would classify as "tricks," which are uninteresting from the standpoint of the program code, or with what he would see as "really interesting" new methods. And yet, Anne is a serious programmer. She has made some technical inventions, and Jeff and the other male hard masters recognize that if they want to keep abreast of the state of the art at their school they must pay attention to what Anne is doing. And Anne knows how to take credit for her achievements. She was heard explaining to a visitor how much she enjoyed seeing versions of her ideas on half a dozen screens: "They didn't copy me exactly, but I can recognize my idea."

Anne wants to know how her programs work and to understand her failures when they don't. But she draws the line between

SHERRY TURKLE is an associate professor in the Program in Science, Technology, and Society at M.I.T. She is the author of The Second Self: Computers and the Human Spirit *(Simon & Schuster, 1984).*

ILLUSTRATIONS: ELIZABETH SLOTE

understanding and not understanding in a way that is different from that of most of the hard-master boys at a similar degree of competence. For the hard masters, a program—like anything else built out of the elements of a formal system—is either right or wrong. It is either free of errors or it isn't. Programs that are correct in their general structure are not "really correct" until the small errors—the bugs—are removed. For a hard programmer like Jeff, the bugs are there to ferret out.

Anne, on the other hand, makes no demand that her programs be perfect. When Anne programs the computer she treats it—in a sense—as a person. People can be understood only incompletely; because of their complexity, you can expect to understand them only enough to get along. The goal is to understand them well enough to maintain the kind of relationship you want. And when you want people to do something, you don't insist that it be done exactly as you want it, but only "near enough." Anne allows a certain amount of negotiation with the computer. What is driving her is not technical perfection but a desire to use visual materials to feel close to the machine.

Anne and the other girls I have observed are trying to form relationships with the computer that bypass "objectivity" in any simple sense. They see computational objects as sensuous and tactile, and they relate to the computer's language not as a set of unforgiving rules but as a way to communicate and negotiate with a psychological being.

A More Tactile Approach

Anne has become an expert at writing programs to produce visual effects of appearance and disappearance. In one program, for instance, a flock of birds flies through the sky, disappears at the horizon, and reappears at some other place and time. If all the birds are the same color, such as red, then disappearance and appearance could be produced by the commands "set color invisible" to get rid of the birds and "set color red" to make them appear. But since Anne wants the birds to have different colors, the problem of the birds' reappearance with their original color is more complicated.

There is a classical method for accomplishing this task: have the program "store away" each bird's original color before changing that color to "invisible" and then recall the colors when the birds are to reappear. This method calls for an algebraic style of thinking. You have to think about variables and use a variable for each color. For example, you could use the letter A to equal the color of the first bird, B to equal the color of the second bird, and so on.

Hard mastery is the mastery of the engineer; soft mastery is the mastery of the artist.

Anne uses this method when she has to, but she prefers a method of her own invention that has a different feel. She lets the bird keep its color, but she makes her program hide it by placing a screen over it. She has designed a computational object (on the Logo computer system she is using, this object is called a sprite) that will screen the bird when she doesn't want it seen. The screen is on top of the bird at all times and moves with the bird wherever it goes. When Anne wants the bird to be seen, the screen is given the "invisible" color, so the bird, whatever its color, shows right through it. When you want to hide something on a canvas you paint it out, you cover it with something that looks like the background. This is Anne's solution. She covers the birds with a sky-colored screen to make them disappear.

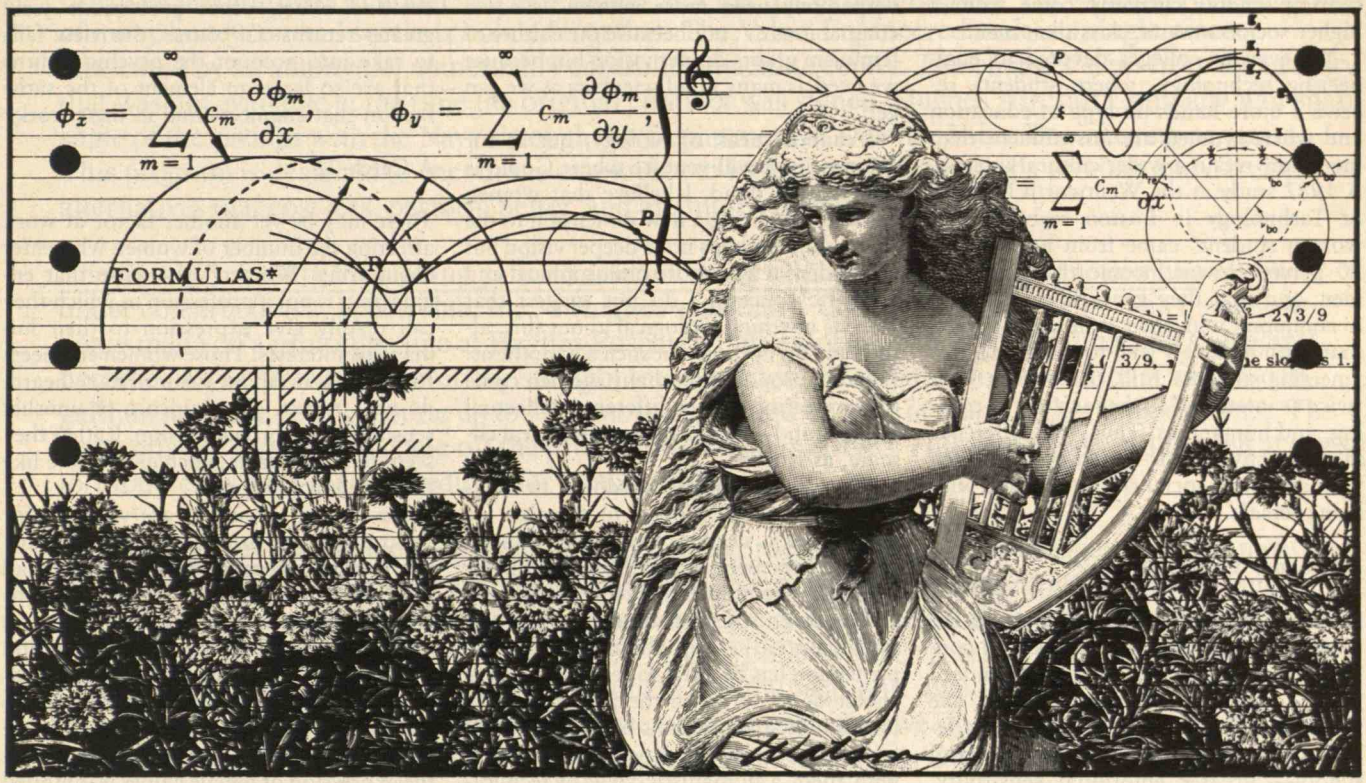
This way of doing things makes Anne feel close to her material. She likes to feel that she is up there among her birds, manipulating them much in much the same way she can manipulate physical materials. Her method allows her to feel that these objects on the screen are close, not distant and untouchable things that need designation by variables. For her the computational object, the sprite, is not to be commanded as an object apart from herself.

Science is usually defined in terms decided by the hard masters. It is the place for the abstract, the domain for a clear separation between subject and object. Similiarly, computer expertise is usually defined in the hard masters' terms: it is the place for a planning style of organization, abstraction, and control. Teachers are first culturally predisposed, and then trained, to recognize hard mastery as "real" mastery. Hard mastery is not just encouraged; it is taught as the right way to do things.

But bringing women into the computer culture requires something different. It requires a commitment to appreciating and exploiting the computer as a medium that different people can appropriate in different ways. For instance, when girls start experimenting with the computer in ways similar to Anne's, they should not be told by teachers or parents that they've "got it wrong." Instead, they should be encouraged to develop their own style of personal mastery. The response of "soft masters" to programming—if they are given the time and the permission to develop their own way of approaching the machine—has a great deal to teach us. In particular, it can teach us how women can find a way—not necessarily the conventional way—to think and talk about the mastery of a formal system, whether it be computer science or mathematics.

Most of today's discussion about computers and women makes the computer the newest actor in an old problem—the long-standing inequity between males and females in scientific/technical domains. But there is another way to think about the computer in which it is not the problem but a possible, if only partial, solution to women's underrepresentation in the world of science. The computer may have a special role in providing an entry to formal systems that is more accessible to women. The computer connects the abstract to the physical, the sensual, and the psychological. Bringing women into the computer culture requires taking a critical look at the social construction of the computer—not just at its categorization as a "male domain" but at the way we think about mastering it. We must recognize that what may be characterized as "male mastery" is not the only type of mastery. □

WOMEN IN TECHNOLOGY



Will Women Engineers Make a Difference?

BY SAMUEL C. FLORMAN

In the Soviet Union women engineers devote three times as much of their leisure time to "humanitarian and artistic activities" as their male counterparts. They read more fiction and go to museums, theaters, and concerts much more often. An unofficial study revealed that they are more willing than men to maintain relations with people frowned upon by the authorities. Asked about the government's treatment of dissident physicist Andrei O. Sakharov, only 5 percent of the women endorsed the party line; among their male colleagues the figure was 24 percent. I came across these interesting facts in a *New York Times* op-ed essay by Vladimir Shlapentokh, an emigre Russian sociologist.

While reading this article, I started to think about the special qualities American women are bringing to the practice of engineering. A survey of freshmen at 15 engineering schools, conducted at Cornell in the late 1970s, found that three times as many women as men enjoyed reading novels, short stories, drama, and poetry. The survey also found that three times as many men as women preferred nonfiction and sports. Women were much more interested than men in participating in preprofessional campus organizations, and they were more likely to choose engineering as a career because the "work itself is interesting." In contrast, more men than women were concerned about high anticipated earnings.

Also during the late 1970s, a study of Purdue engineering students found that women felt more strongly than men that a liberal-arts background is essential for engineers. More recent studies carry the same sort of message. A sociologist at Franklin and Marshall College, who interviewed students at 20 engineering schools last year, found that women are more inclined to enter "humanitarian" fields such as environmental and biological engineering, while men are more interested in aerospace, electrical, mechanical, nuclear, and petroleum engineering. The sociologist also found that women attending prominent U.S. engi-

SAMUEL FLORMAN, a civil engineer, is author of Engineering and the Liberal Arts, The Existential Pleasures of Engineering, *and* Blaming Technology.

ILLUSTRATION: KAREN WATSON

Women do indeed bring a view to engineering that reaches beyond the narrowly technical.

neering schools currently come from a higher socioeconomic class than men.

Yet even at colleges devoted to engineering technology, where students receive a more hands-on type of education and where women are *less* affluent than men, they retain a wider cultural interest. A 1982 study at the Wentworth Institute of Technology in Boston revealed that women students came from homes with 20 percent lower income than those of men, and that they generally had "more in common" with their male counterparts than with relatively well-to-do women engineering students. Still, the women were twice as interested as the men in art, reading, and humanities. Thus, this difference in perspective seems not to be associated with money or social class but rather with being female.

A Broader Vision?

Although these are just a few straws in the wind, the findings are remarkably consistent. It appears that women do indeed bring a new outlook to engineering, one that is marked by—in the words of a female philosopher at an engineering school—"greater emotional sensitivity, more extroversion, stronger intellectual interests, and broader concerns beyond the narrowly technical."

According to one view, this is only what one would expect. Marilyn Ferguson, in her book *The Aquarian Conspiracy*, puts it this way: "Women are neurologically more flexible than men, and they have had cultural permission to be more intuitive, sensitive, feeling." To others, such an association of women with sensitivity is anathema. Simone de Beauvoir, whose *The Second Sex* is a landmark work of the feminist movement, recently was asked about the "new femininity . . . the emphasis on feelings rather than intellect." Her answer was unequivocal: "I think it's a return to the enslavement of women, pure and simple!" To claims that women are closer to nature than men, she responds, "These are attempts to divert women from their struggle for emancipation and to channel their energies into subsidiary concerns."

Obviously one can't have it both ways. Either women are more sensitive than men or they aren't. The safest course is to say that they aren't. Thus, Stephen Jay Gould, reviewing a recent feminist book on biology, makes this cautious statement: "We desperately need more women as equal companions . . . not because the culture of feminism grants deeper vision but because we need as many good scientists as we can get."

I cannot speak of biology, but as for engineering I will venture where Gould is reluctant to tread. I believe that women definitely do bring a new dimension to the profession, perhaps not a deeper vision but a broader view, a more philosophical and aesthetic concern. I do not suggest that there is anything biological about this, although I do not rule out such a hypothesis. I merely propose that many women come to engineering from a different intellectual background—from a different cultural climate, as it were.

Also, even though the doors to engineering have been open to females for more than a decade, the young women choosing the profession today are still, by definition, venturesome. That is, they are willing to go where relatively few of their sex have gone before, whereas for men the profession has become so sensible a career choice as to verge on the pedestrian. An infusion of adventurers—hailing from different cultural landscapes and bringing with them a humanistic view of technology—is just what our somewhat stuffy profession needs. I hasten to add that this does not mean that women are not as adept as men at conventional engineering tasks; their work in the classroom certainly bears this out.

I write with some trepidation because when I previously addressed the question of women in engineering my words evoked considerable response, much of it far from friendly. In 1978, in an article in *Harper's*, I challenged the reasons usually given for the low numbers of female engineers—male hostility, teacher prejudice, lack of role models, for instance—and suggested that talented young women were avoiding engineering because they perceived other professions as more direct routes to political power and social prestige. Six years later, the percentage of women studying engineering is only slightly increased—and is still inordinately low compared with the percentage studying law, medicine, and business—and I still believe that this is related to the engineer's relatively humble social status. The perception is widespread—among minority students as well as women—that if you're smart enough to be an engineer, you're too smart to be an engineer. In other words, for the same talent and effort, other professions yield greater returns. Of course, this view fails to take into account the psychic returns that are so large an element of the satisfaction that engineers find in their work.

A Catch-22

There may be yet another factor at work affecting the number of women who enter engineering. Women may sense that engineering is not a profession in which they can readily give expression to their humanistic interests. Those women engineers I have met, or about whom I have heard, do not, in fact, give evidence of unusual sensitivity or a broader vision. Rather they seem to be acting as much as possible like their male colleagues.

No women engineers are working for the construction firm in which I am a partner, basically because we have never had any women apply for engineering jobs with us. We do, however, employ some women as technical project managers, and I have found that they act very much as the men do, mostly because they want to feel accepted by their male peers. So we may be in a Catch-22 situation, in which the expression of female values is inhibited because of the small percentage of women in the profession. At the same time, women are not entering the profession because they see no evidence therein of the values they profess.

It is important to stress that I am not talking about refinement of manners. I heartily approve of women engineers adopting rough and ready ways where roughness and readiness are appropriate to the task at hand. Nor am I talking about superficial cultural veneer. I am addressing the need for engineers—men as well as women—to be liberally educated, so that their own lives can be enriched, their profession ennobled, and society improved.

Engineers who are able to communicate as well as solve problems, who work well with other people, and who are informed about and sensitive to key social and political issues make better leaders. And we certainly could use more engineers in positions of leadership in this highly technological age. Thus, I believe there would be a clear benefit to society from having more women in engineering, as well as from having more men with a heightened appreciation of the values inherent in a liberal education. □

SCIENCE/SCOPE

A redesigned equipment rack for the F/A-18 strike fighter's radar will allow the U.S. Navy and Marine Corps to save millions of dollars on new radars over the life of the program. The original rack consisted of many honeycombed sections bonded together. The Value-Engineered rack is a single piece fabricated by an automatic, numerically controlled machine center. The changes stem from technology that was not available at the time the original contract was signed. Hughes Aircraft Company will share some of the savings with the Navy through the Department of Defense Value Engineering program. This program is designed to encourage employees to look at the functions of a product and develop alternatives that cost less, perform better, and are more reliable.

The first U.S. facility for making gallium arsenide solar cells on a standard production line is now under construction at Spectrolab, Inc., a Hughes subsidiary. Gallium arsenide cells, which are now being made on a prototype line at Hughes Research Laboratories, will help satellites and spacecraft become more efficient in converting sunlight into electricity. Compared to conventional silicon cells, gallium arsenide cells generate up to 30% more power and operate at much higher temperatures. The first cells are expected to come off the production line in mid-1985. Full-scale mass production at rates to 15,000 cells per year is scheduled for January 1986.

Two high-power communications satellites have been ordered by Advanced Business Communications Inc. (ABCI). The satellites are widebody HS 393 models, now being developed at Hughes for launch from the space shuttle. The drum-shaped spacecraft are designed to fill the width of the space shuttle's cargo bay in order to take advantage of launch pricing policies. Each satellite will operate over the Ku band and carry 16 channels designed for business communications, video distribution, and teleconferencing. The spacecraft's higher power will let users receive signals through small, low-cost earth terminals. Hughes Communications Inc., a Hughes subsidiary, will provide launch, tracking, telemetry, and control services for the Ku band system. Hughes Communications Galaxy Inc. will market 16 transponders.

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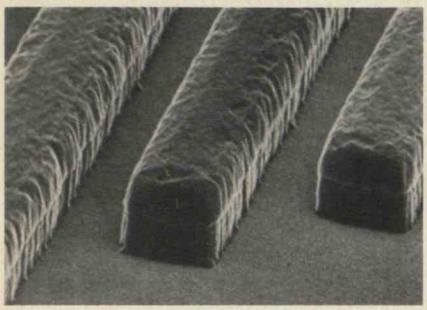
the 1 μm barrier.

nition begins to blur, and other techniques are needed. Among these is electron-beam lithography, with sub-micron resolution.



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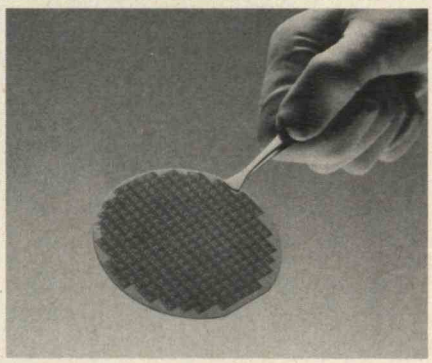
In the box at the right is a partial list of pertinent papers by GTE people on VLSI and related subjects. For any of these, you are invited to write GTE Marketing Services Center, Department TPIC, 70 Empire Drive, West Seneca, NY 14224.



Pertinent Papers.

End Point Detection for Reactive Ion Etching of Aluminum, J. Electrochem. Soc., 1984.

Highly Selective Dry Etching of Polysilicon Using Chlorinated Gas Mixtures for VLSI Applications, Electrochemical Society Meeting, May 6-11, 1984.

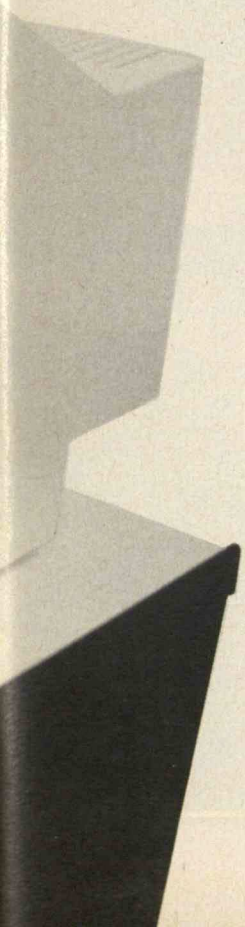
Negative Resistance Switching in Near-Perfect Crystalline Silicon Film Resistors, 30th American Vacuum Society Symposium, November, 1983.

Vertical, Dual-Gate CMOS NAND in Two Laser-Recrystallized Silicon Layers over Oxidized Silicon Substrate, Materials Research Society Spring Meeting, February, 1984.

Reactive Sputter Etching of Single Crystalline Silicon, Proceedings of 3rd Annual Symposium on Plasma Processing and Extended Abstracts 83-1, 163 Electrochemical Society Meeting, May, 1983.

Reactive-Ion Etching of Single Crystalline Silicon with $Cl_2 + SiCl_4$, Proceedings of Fourth Conference on Plasma Processing, Electrochemical Society Meeting, May, 1983.

GTE



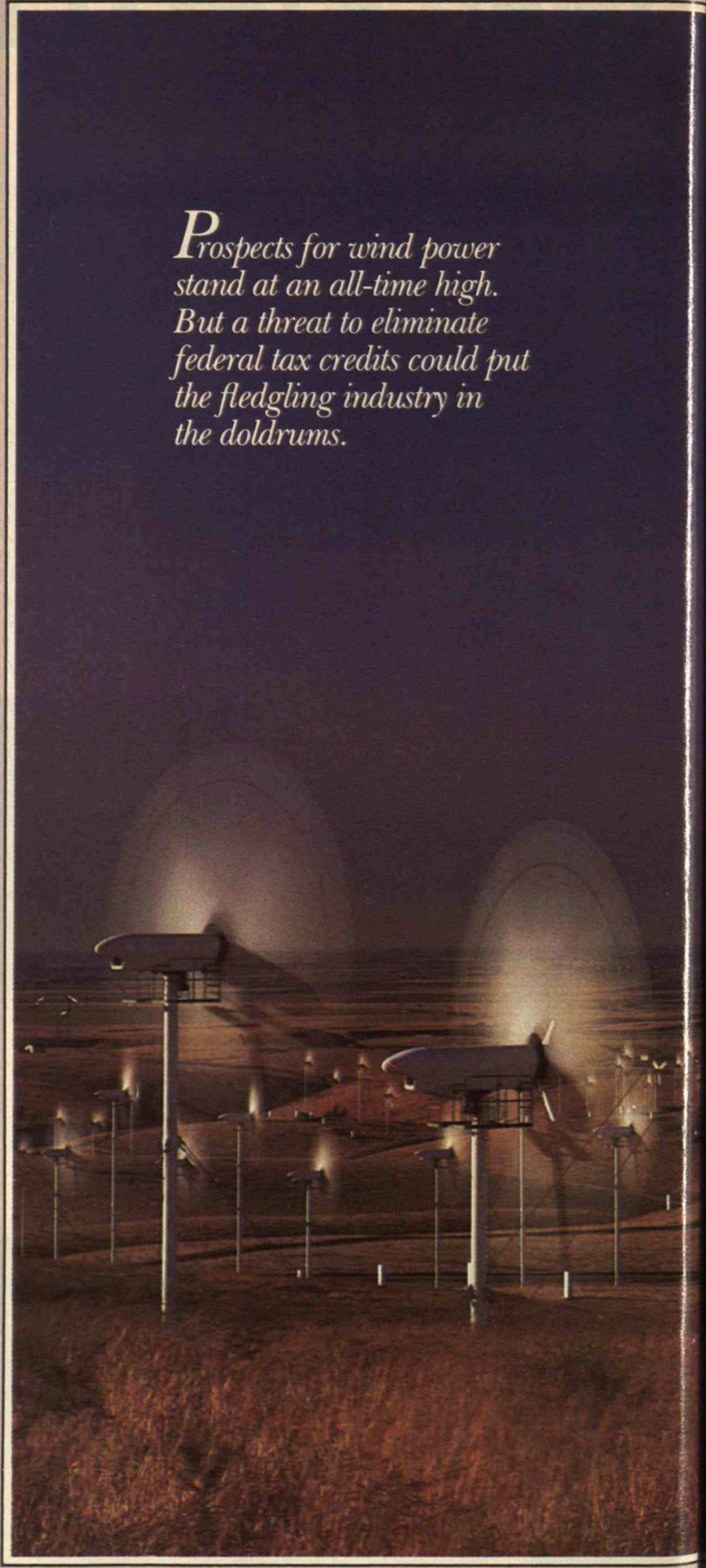
ENERGY

A SPECIAL REPORT

Harvesting the Wind

BY ROBERT D. KAHN

Prospects for wind power stand at an all-time high. But a threat to eliminate federal tax credits could put the fledgling industry in the doldrums.



THE locals call it "windy gulch." But Altamont Pass, a narrow gap through the Coastal Range 40 miles east of San Francisco, is anything but a wasteland: it is home to the world's largest concentration of electricity-producing windmills. Row after row of turbines, perched atop towers 60 to 100 feet tall and sporting rotor blades up to 70 feet across, march across the rolling hills. These privately owned "wind farms" sell their product to the local utility, Pacific Gas and Electric, for distribution to its customers.

Altamont's wind farms testify to the rapid growth of wind power in California and to the potential contribution this renewable energy resource may make nationwide. It started with a handful of windmills dotting the pass in 1981; by the end of 1983, some 2,500 turbines were churning out electricity. The farms represented roughly 150 megawatts of generating capacity—enough to meet the electrical needs of 50,000 households. This year's crop of turbines will more than double Altamont's generating capacity, according to the California Energy Commission (CEC).

The Tehachapi Mountains north of Los Angeles and the San Gorgonio Pass near Palm Springs are also blessed—the word might once have been "cursed"—with ample winds, and wind farms in both areas now boast more than 1,000 turbines. Statewide, total generating capacity should hit 740 megawatts by year's end, says Michael Batham, CEC's wind-program manager. He adds that "1,250 me-

PHOTO: THOMAS BRAISE, FAYETTE MFG.

gawatts of capacity is not out of the realm of possibility by the end of 1985," and that wind farms may be able to supply 8 percent of the state's electricity needs by the year 2000.

Independent energy developers in other states are also stepping up efforts to develop wind power. New wind farms are going up in New Hampshire, Montana, Oregon, Kansas, and Hawaii, and a California-scale operation with 71 machines is planned for the Catskill region in New York. Sales of wind hardware, worth $290 million in 1983, should reach $410 million this year, according to John Day, president of the market-research firm Strategies Unlimited. The American Wind Energy Association projects that there may be as much as 900 megawatts of generating capacity on-line nationwide by the end of the year. And as a long-range forecast, the Worldwatch Institute in Washington, D.C., recently reported that wind could provide 14 percent of the nation's projected demand for electricity by the turn of the century.

But there's a potential snag in such predictions. The recent surge in the growth of wind farms has been due largely to favorable tax laws. In 1980, Congress enacted a special 15 percent tax credit for investments in renewable-energy technologies. This is on top of the standard 10 percent investment tax credit. However, the energy tax credits are slated to expire at the end of 1985. (California investors have an added incentive: a 25 percent renewable-energy credit on state taxes. This credit will expire at the end of 1986.)

Leaders in the wind-energy field and others fear the fledgling industry will suffer greatly if the federal energy credits are eliminated. "The industry may die in the cradle," says Bill Julian, consultant to the California Assembly Utilities Committee. Nearly every company in the field would face serious difficulties and there would be a major shakeout, says CEC's Batham. "It would set the industry back five years, maybe ten years—who can say? Some companies will be able to stay in business, but even they will be forced to move ahead much more slowly," he adds.

What is needed is just a bit more time, goes the general refrain. Indeed, the industry seems poised at a fragile stage between R&D and full-scale commercialization. Costs are on the way down, but they may not drop fast enough to maintain investor interest without the tax credits. Strategies Unlimited, for example, sets the current cost of wind-generated electricity at 12¢ to 15¢ per kilowatt-hour. Others in the field estimate the cost to be as low as 7¢ or as high as 17¢ per kilowatt-hour. This makes wind competitive with the more expensive nuclear plants coming on line. And researchers at Battelle Laboratories report that wind should be able to compete with conventional fuels by 1990 and perhaps even within the next several years. By comparison, they predict that photovoltaic cells won't be competitive until the mid-1990s.

Choosing a Good Site

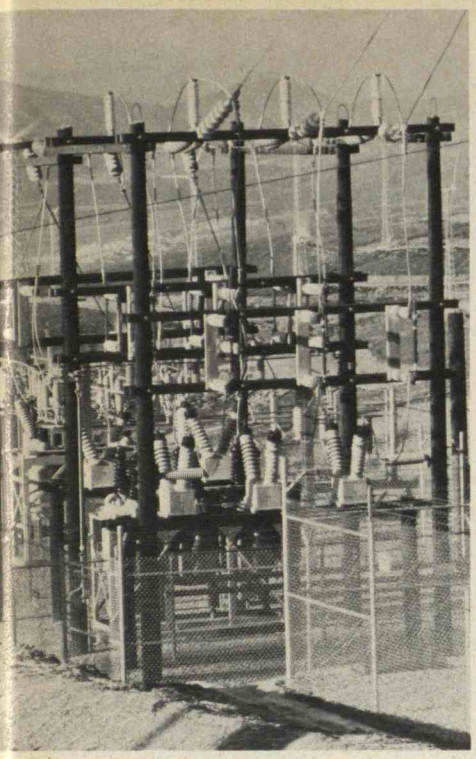
Wind-farm developers gravitated to Altamont Pass because of its ideal combination of winds, nearby markets, and available transmission lines. The right wind site can make the difference between a profitable venture and an expensive kinetic sculpture. In technical parlance, the power in wind is proportional to the cube of its speed. This means that as wind speed doubles, available power increases by a factor of eight. Therefore, a 3 percent difference in average wind speed can alter power production by almost 10 percent.

The winds at Altamont and the other areas favored by California wind farmers result from the great temperature difference between the cool coast and the hot interior valley. Since hot air rises and cool air sinks, the powerful difference in atmospheric pressure brings air surging inland. Where the air funnels through a natural gap—voilà, "Windy Gulch." During California's "windy season," which runs from March through October, gales of 30 to 40 miles per hour sweep through the Altamont Pass for 12 hours a day or more. The seasonal factor, of course, limits the time when wind farms can make electricity. "Fortunately," says Thomas Braise of Fayette Manufacturing Corp., a turbine maker and local wind-farm developer, "when the utility needs electricity the most is when we can generate the most."

But a windy site is only part of the story. Developers need power sales contracts—commitments from local utilities to buy electricity for an agreed-upon price and duration. Utilities had little incentive to buy wind power until 1978, when Congress passed the Public Utilities Regulatory Policies Act. PURPA requires utilities to "interconnect" with small, independent power producers and pay them the "full avoided cost"—the dollar amount the utility would otherwise have to pay to produce the electricity itself. "PURPA created a market for renewables," says Jan Hamrin, director of California's Independent Energy Producers. "After PURPA, utilities no longer had a monopoly on providing electricity."

Winds on Wall Street

When wind-energy entrepreneurs needed money to pay for building their dreams, they found the rainbow's end on Wall Street. Paine Webber, Merrill Lynch, and other leading brokerage houses now market wind energy aggressively. This has made available a steady stream of money that couldn't be obtained from conventional lenders such as banks, which are notoriously conservative in taking invest-



Many wind farms are turning to Danish machines, such as these in the Tehachapi Mountains, because their durability offers steady performance.

ment risks. But Wall Street's very success in attracting investors is helping spark the controversy that may ultimately halt the industry's growth.

Opponents vehemently attack wind-farm investments as nothing more than tax dodges for rich investors. Congressman Fortney ("Pete") Stark, a California Democrat who is one of the industry's most vocal critics, told *Forbes*, "These aren't wind farms, they're tax farms." He was also quoted in a newspaper in his home district—which ironically includes Altamont Pass—as saying bitterly that taxpayers would be better off hiring "thousands of little kids to sit on bicycles and pedal away to produce power" rather than subsidizing wind power through the tax laws.

Stark's attack has some basis. "Some packages have been sold that are nothing but egregious tax shelters," says Edward Blum, executive director of Merrill Lynch's Alternative Energy Finance Group, "though not by the major brokerage firms." For example, in some well-known cases wind machines with plywood blades were hurriedly erected to beat the year-end rush for tax credits. But even though wind farms admittedly make excellent shelters, the government's "loss" in taxes is modest. With $300 million spent on wind-farm developments last year, industry officials say the cost to taxpayers totalled only $75 million.

Learning from Failure

Wind energy's respectability should also get a boost from a flurry of technological improvements. In the industry's "early days"—roughly 1981 through early 1983—the name of the game was putting up machines. The failure rate was high: many machines suffered from high maintenance costs, considerable downtime, and poor energy production. Some manufacturers rushed virtually untested products to the field. "We saw serious problems with many machines that often called for drastic engineering redesign," says CEC's Batham.

But as competition within the industry increased, most manufacturers were forced to improve their products rapidly by analyzing their field experiences and designing new machines. The results are promising: Batham says today's operational problems are generally less crucial. "Manufacturers now face such tasks as readjusting the angle of the rotor blade to optimize performance," he says, "where they once had to find ways of simply keeping the blades on." The improvements are also showing up in turbine reliability, which, "measured as the amount of time a machine was available to run when it was needed, was once off the charts," Batham says. "Today's machines are averaging perhaps 85 percent availability, with some machines up to 95 percent." In fact, some manufacturers now guarantee 90 percent availability over five years.

However, some insiders still see ample need for more R&D and technological improvements. Woody Stoddard, a leading machine-design consultant with Pioneer Wind, says many manufacturers are still "preoccupied with immediate sales and only marginally interested in production engineering, research, and orderly phasing in of prototype turbines." Even Thomas Gray, president of the American Wind Energy Association (AWEA), has cautioned: "If we don't concentrate enough on the equipment, as opposed to building better tax deals, we could easily lose the support we've had." Part of the problem is that many manufacturers emphasized performance at the expense of reliability, says Stoddard. In other words, when the turbines worked, they cranked out a lot of power—but their complexity made them prone to trouble.

This lack of reliability has led a growing number of wind-farm developers to turn to foreign machines, and especially to Danish turbines. Though the Danes have five manufacturers selling machines here, the units are essentially the same. They are relatively simple in design—inspired by traditional Scandanavian windmills—and are "overengineered" for durability. It's no mistake that the Danish machines are built like tractors; several of the manufacturers started out building farm equipment, and farm sales still account for most of their domestic sales. But Stoddard says all is not lost for U.S. firms. "A mix of sophisticated design and attention to reliability will bring still-higher performance within our grasp," he says. "That's the Americans' long-term marketing advantage."

Still, Danish turbines accounted for 10 percent of the machines purchased by U.S. wind farms last year, according to AWEA, and that share could easily triple in 1984. Indeed, three wind-farm developers—Zond, Airtricity, and Arbutus—now exclusively install Danish machines from Vestas, Windmatic, and Bonus. One reason the companies give for switching

PHOTOS: CARA MOORE

This gallery of wind farms testifies to the rapid growth of wind energy in California, where thousands of turbines have sprouted seemingly overnight.

to these machines is that their farms are primarily in the Tehachapi Mountains, a rugged region where storms are frequent and failed machines are difficult to service.

Thinking Bigger

Wind enthusiasts have long debated the relative merits of small turbines with less than 100 kilowatts of capacity versus multi-megawatt machines. NASA's Lewis Research Center has conducted the premier R&D effort with large turbines under sponsorship of the Department of Energy. Begun in the early 1970s, this research has resulted in the MOD-2 machines built by Boeing Co. Standing 350 feet tall and equipped with a 300-foot rotor, these giants can capture more and stronger wind, giving each a generating capacity of 2.5 megawatts.

Several of these machines are now operating, including a turbine that Pacific Gas and Electric is testing at a site northeast of San Francisco. But the MOD-2s have run into numerous technical problems that cloud their commercial future. Indeed, the Electric Power Research Institute recently declared its fear that too much "complexity and cost have been built into large wind turbines." The machines may still have a commercial future, says EPRI, but their future "may simply be further off than once believed."

On the other hand, small turbines don't look practical for carrying wind farms into the big time, either. Indeed, manufacturers, developers, and researchers are reaching agreement that "intermediate" turbines are the best bet. Some 50 200-kilowatt and 10 400-kilowatt machines are already operating on Altamont wind farms, generating electricity as well as experience. And although the optimal turbine size has yet to be determined, EPRI officials think that economics and technology may converge at the 1-megawatt level for the foreseeable future.

Put It in Writing

However, the most pressing matter facing the wind-energy industry remains the fate of the federal tax credits. The House Ways and Means Committee has slated hearings for early 1985. In the Senate, the Science and Technology Committee has commissioned the congressional Office of Technology Assessment to study the effect of the credits on industry development, with a report expected in March.

Given Washington's current concern with the burgeoning federal deficit, the outlook isn't bright. "Unfortunately, energy isn't a sexy topic anymore," says Pat Fulton, energy aide to California Congressman Vic Fazio, a leader in past credit fights. "It doesn't seem to matter how many tankers are blown up in the Persian Gulf." However, CEC's Batham says there is some talk about maintaining the credits but "stair-stepping" them down—cutting them to 10 percent and then 5 percent before abolishing them in several years.

Industry leaders fear that in this climate some firms may serve as wind power's own worst enemies. By hyping a "wind rush" mentality in the financial community, developers and manufacturers may play into the opposition's "tax-farm" rhetoric, undermining the industry's case in the next Congress. "While the credits have accelerated the industry's growth," says AWEA's Gray, "they have also created a temptation to go for the fast buck. But if a few sizable projects fail and investors get burned, wind energy can quickly lose the political support and positive investment climate it enjoys today."

The CEC is now developing mandatory performance standards to avoid such problems. Beginning in January, the agency will require wind-farm developers in California to file quarterly reports on machine capacity, performance, and amounts of electricity produced from their installations. "The standards will help the industry by helping investors judge the performance of various machines and developers," says Batham. Such standards may also help the industry gain congressional extension of the credits. Indeed, key wind-power leaders are soon expected to offer a plan linking credit elegibility to kilowatt-hour production, hoping that this will defuse the harshest criticisms.

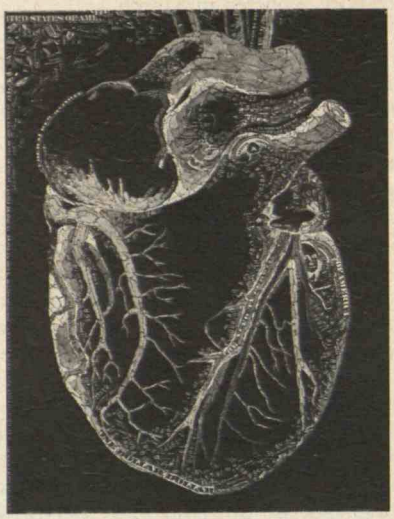
There seems to be wide agreement, within and outside the industry, that wind power will soon be able to stand on its own—given a bit more help. It would be ironic if this promising alternative-energy industry, driven by entrepreneurs and spawned with modest federal support, were allowed to collapse beside an ailing utility industry. □

ROBERT D. KAHN is president of Robert D. Kahn, Inc., a public-relations firm based in Davis, Calif., specializing in renewable energy.

PHOTOS: ED LINTON, U.S. WINDPOWER; CARA MOORE; GEORGE HALL; EPRI JOURNAL; PETER MENZEL; THOMAS BRAISE

The Misguided Quest for the Artificial Heart

Continued from p. 19



plants, derisively likened the Utah action to putting "John Glenn in a rocket in 1950 and aiming him at the moon." Though Cooley soon softened his harsh judgment, the fact remained, as he had emphasized, that the quality of life on an artificial heart would be poor—constant noisy thudding in the chest and the immobility of being tied to external power. Dr. Norman Shumway of Stanford, another prominent heart surgeon who preferred transplants, described the artificial heart as "crude" and inappropriate. Even Kolff, given to wild predictions that artificial-heart recipients would be barred from marathons within 15 years because they would be too strong, had stipulated that the device would be a success only if Clark was happy. "That has always been our criterion," he explained, "to restore happiness."

Shortly after the operation, Kolff Medical, Inc., the company that made Jarvik 7 and was now headed by Jarvik, announced that it had raised $20 million dollars from investors. Because the firm had previously issued stock and options to employees, Jarvik and Kolff were suddenly worth over $6 million each on paper, and DeVries about $350,000.

Officials at the National Heart, Lung, and Blood Institute (NHLBI), the successor to NHI that had provided much of the financial support for the Utah research, were privately annoyed by the implant. But because the Utah group did not have any NHLBI funding for the Jarvik 7 at the time, the agency—which had never formulated standards for experimental use of the heart—had no authority over the decision.

Troubling Issues

The operation on Barney Clark raises troubling questions about the ethics and politics of this experiment. Was Clark's death possibly hastened—rather than delayed—by implantation of the artificial heart? Were the FDA standards that allowed the use of questionable valves sufficiently demanding, considering that about 20 had proved defective and some had killed animals? Was the experiment premature, and did Clark have any real chance for the "happy life" that Kolff had stipulated, or even the six or seven months of extended life that Nosé had forecast?

Early death is likely for anyone suffering from cardiomyopathy, as Clark was. But the prediction of imminent death is not reliable during the illness, and thus experiments may be conducted on individuals who might live longer without the device. As Peterson had himself admitted earlier, "However ill a person may be, no one can predict the exact longevity of a living heart or the implications of replacing it with an artificial one." This problem is underscored by the case of a Florida firefighter, suffering from cardiomyopathy and judged near death, who had sought an artificial heart from the Utah team in April 1982, eight months before Clark's operation. Although he was turned down, he actually went on to outlive Barney Clark by about a year.

Clark's operation was basically an experiment. There was no realistic basis for concluding that he was going to live a comfortable life. His new heart made him susceptible to infection and largely immobile. At best, if Nosé's optimistic prediction had been correct, Clark might have lived only a few more months.

Nor was Barney Clark, when judged by medical standards, a good choice for this experiment. After his death, several members of the Utah hospital review board complained that the doctors had overlooked problems with his other organs, particularly his lungs. In their concentration upon Clark's poor heart, DeVries and his associates had reportedly not recognized his severe emphysema, perhaps the result of his 25 years smoking two packs of cigarettes a day. The condition of his lungs may have been worsened by anesthesia and the major operations.

Should not the NHLBI have drawn up clear, well-publicized guidelines on what kind of artificial heart was acceptable in an experiment on humans? For years, the agency had avoided raising—much less resolving—the basic questions.

The Lingering Problems

Other problems—of cost, justice, and control—continue to hang over the artificial-heart program. The earlier estimates that implanting a heart would cost $25,000 to $60,000 proved wildly optimistic: Barney Clark's expenses exceeded $275,000. As a retired dentist he might have been able to pay the bill, even if medical insurance and donations had not covered it. But unless America is going to restrict artificial hearts to the wealthy, the government that contributed over $200 million in development costs would have to pay for most other operations of this type. With a likely average cost of $125,000 to $250,000 for possibly 50,000 patients, that would mean $6.25 to $12.5 billion per year. That's roughly 2 to 4 percent of the nation's medical budget for .02 percent of the population. The benefits for individuals with heart disease would not be great—between, on the average, eight months ("best case") and eleven weeks ("worst case") for a 25-year-old, and between two months ("best case") and two days ("worst case") for a 55-year-old.

The possibility of meaningful political control over the development and distribution of the artificial heart may slip away. Business firms, less susceptible to effective control than medical schools such as Utah's, may soon dominate the artificial-heart business. Indeed DeVries, complaining of delays by the University of Utah's Institutional Review Board (IRB), recently moved to Louisville, Ky., to join the Humana Heart Institute owned by Humana, Inc. It is America's third largest for-profit hospital company and a major stockholder of Symbion, the successor firm to Kolff Medical. Humana has promised to subsidize up to 100 implants. DeVries believes that Humana's ethics panel, the counterpart to Utah's IRB, will create fewer problems for him. Since the committee is apparently dominated by the firm's employees, DeVries is probably correct. Put another way, independent judgment may yield to Humana's quest for prestige and profits.

DeVries' move to Humana is a dramatic reminder that biomedicine is big business, that the artificial-heart business is attractive to venture capitalists, and that researchers who earlier benefited from federal funding can build upon that work, keep many of their discoveries secret, and even slide away from federal oversight. Their own conception of "doing good"—whether pushing for FDA approval, pressing the IRB, or selecting another heart recipient—may be influenced, often subtly, by their own quest for fortune and fame.

Unless Congress decides to exercise more scrutiny and control, investors and researchers—not the polity—are likely to determine the development of the artificial heart. Congress has not yet focused on the possibility that its present $10 million annual program might leap to yearly costs of $6.25 to $12.5 billion. Legislators will eventually have to face the issue they have avoided—whether to pay for artificial hearts or allow only the wealthy to have them. In the process, America will either strain its medical budget or move further away from the standard of providing health care as a right.

Prescriptions for Decisions

Why should money be spent on the artificial heart rather than on finding ways to help people prevent heart disease? Perhaps an ideal society with unlimited resources could do both, but this is not such a society. The sense of abundance of the mid-sixties has faded. Social programs are being cut back. Medical care for the poor—whether young or old—is often unavailable. The emphasis on a glamorous technology may mean the sacrifice of other medical programs that benefit more people for a longer period. The issue is not the $9 million to $12 million annual expenditures for development, but the huge cost of an artificial-heart project serving possibly 50,000 patients annually.

Why are technological "fixes" more attractive than preventive measures? Part of the answer is that prevention, by its nature, seldom involves a dramatic intervention, a glamorous struggle against death. The required activities are systematic and even repetitive. In prenatal care, for example, diet and medical checkups are the keys to healthier mothers and babies, and lower mortality. Preventing heart disease seems to involve daily do's and don'ts—among them, eating a well-balanced, moderate diet, not overeating, getting exercise, and not smoking. Research that would easily double NHLBI's skimpy budget for prevention remains to be done on weighing the factors that contribute to heart disease and defining precise standards for avoiding it.

Research in preventive medicine seldom captures headlines or creates heroes. Even when it does, it is usually for some dramatic chemical intervention—for example, the polio vaccines of Jonas Salk and Albert Sabin. We admire the success of scientists in controlling nature by some dramatic device or chemical. Intervention—beating nature—helps make high-technology medicine glamorous.

Heart surgeons and bioengineers are, accordingly, grand candidates for "heroes." Because the heart, like the brain, is defined as the seat of life, the surgery has glamor. The artificial heart represents the defiance of death.

There is a need to reevaluate how we spend our money on health—to reconsider purposes, means, and emphases. There is no easy route to redefining priorities, for the present ways often have the support of established institutions and cozy alliances. They also fulfill some of the larger values in the society while clashing with others.

But one way to change priorities, suggested by the artificial heart and other forms of biotechnology, is to broaden decision making, to acknowledge uncertainty, and to challenge accepted expertise. Such involvement, possibly including citizen participation at various levels, may allow us to have greater control of our world. At a minimum, biomedical experts would be compelled to defend their predictions and analyses. For what experts propose, and ultimately what they create, especially in technology, shapes society in subtle but powerful ways. Issues involving technology in general, and biomedicine in particular, are not value-free but value-laden. The quest to "do good" is profoundly ideological.

BARTON J. BERNSTEIN is a professor of history at Stanford University, specializing in foreign policy, the arms race, and science and technology policy. He is a member of an interdisplinary group at the Stanford University Medical Center that is preparing a book on biomedical innovation and public policy.

Beyond MAD

New Ideas in Arms Control

Weapons and Hope
by Freeman Dyson
Bessie/Harper & Row, $17.95

The Abolition
by Jonathan Schell
Knopf, $11.95

Reviewed by Carolyn Meinel

Both popular protest and a new group of innovative thinkers have badly shaken the nuclear arms-control orthodoxies that have persisted virtually unchanged since the 1950s. Nowhere is this more evident than in two recent books, *Weapons and Hope* by Princeton physicist Freeman Dyson, and *The Abolition* by *New Yorker* staff writer Jonathan Schell. Both authors want to move beyond the doctrine of mutually assured destruction (MAD)—the idea that superpowers will be deterred from using nuclear weapons because of the holocaust that would ensue—and want to abolish nuclear forces entirely. And surprisingly, given their different backgrounds, the authors come to similar conclusions on how to do this: both advocate pursuing a ballistic-missile defense (BMD), as President Reagan has proposed in his Strategic Defense Initiative. These conclusions have provoked some consternation among professional arms controllers while causing some BMD supporters to broaden their thinking.

Even though Dyson has consulted for both the Pentagon and the Arms Control and Disarmament Agency, he is also a supporter of the nuclear-freeze movement. "I write because I live in two worlds, the world of the warriors and the world of the victims, and I am possessed of an immodest hope that I may improve mankind's chances of escaping the horrors of nuclear holocaust if I can help these two worlds to understand and listen to each other." Still, Dyson reveals his warrior mindset by shrugging off the threat of nuclear extinction. He admits it is possible, though by no means certain, that we have the potential to destroy the human race, but then hurries on to more hopeful topics, explaining why he favors BMD. He believes that "deterrence brings us into a world of upside-down logic which considers weapons of self-defense evil and weapons of mass murder good. . . . We are led to ask whether our reliance on the theory of deterrence as a permanent guarantee of our survival may not be the greatest technical folly of all."

Yet Dyson also rejects the idea that simply developing a technical fix—a space-based BMD—will solve all our problems, as no technology ever works exactly as expected. (He cites as an example the antiaircraft system developed by the British during World War II that was designed to use radar to shoot down enemy planes automatically. Although the system was 100 percent effective in tests, it was never used because distinguishing between friendly and enemy aircraft proved impossible.) Dyson's solution is the defense-dominated future that chooses to begin to disarm nuclear forces on the ground and *then* to let space forces grow, "in the hope that a disarmed world will settle down more comfortably if it has space forces providing substantial protection against the risks of surprise attack."

Weapons and Hope has become must reading for professionals working on the Strategic Defense Initiative (SDI). For example, Major General E.R. Heiberg, director of the army's ballistic-missile defense program, has urged his staff to read the book, and top officials of the Arms Control and Disarmament Agency met with Dyson this spring to explore his concepts in greater depth. Richard Sellers, who codirected the anti-freeze effort of the Coalition for Defense Preparedness and now works full time as a pro-BMD lobbyist, says he was especially moved by Dyson's book. Perhaps because Dyson explains the need for reducing arms on the ground before deploying BMD, Sellers says he now realizes "the freeze people and I are on the same side."

Dyson's concepts may even have prompted the Reagan administration to change its arms-control positions. The president's current view that talks with the Russians over controlling the militarization of space must be linked with arms control on the ground is pure Dyson.

Meanwhile, both John Pike of the Federation of American Scientists and a staffer of Senator Paul Tsongas (D-Mass.) have decided that *Weapons and Hope* bolsters their opposition to BMD. "I am surprised BMD advocates have taken it to heart," says Pike. "Maybe I'm reading a different edition?" He suggests that if we need a defensive system only as a hedge against cheating on an arms-control agreement, then Nike/Zeus, a sixties-vintage anti-ballistic missile designed to disable incoming warheads with nuclear explosions, would do the job. Tsongas' staffer also argues that the book "is clearly a scathing indictment of SDI plans as outlined for Congress . . . this is the best case for space arms control I have seen to date."

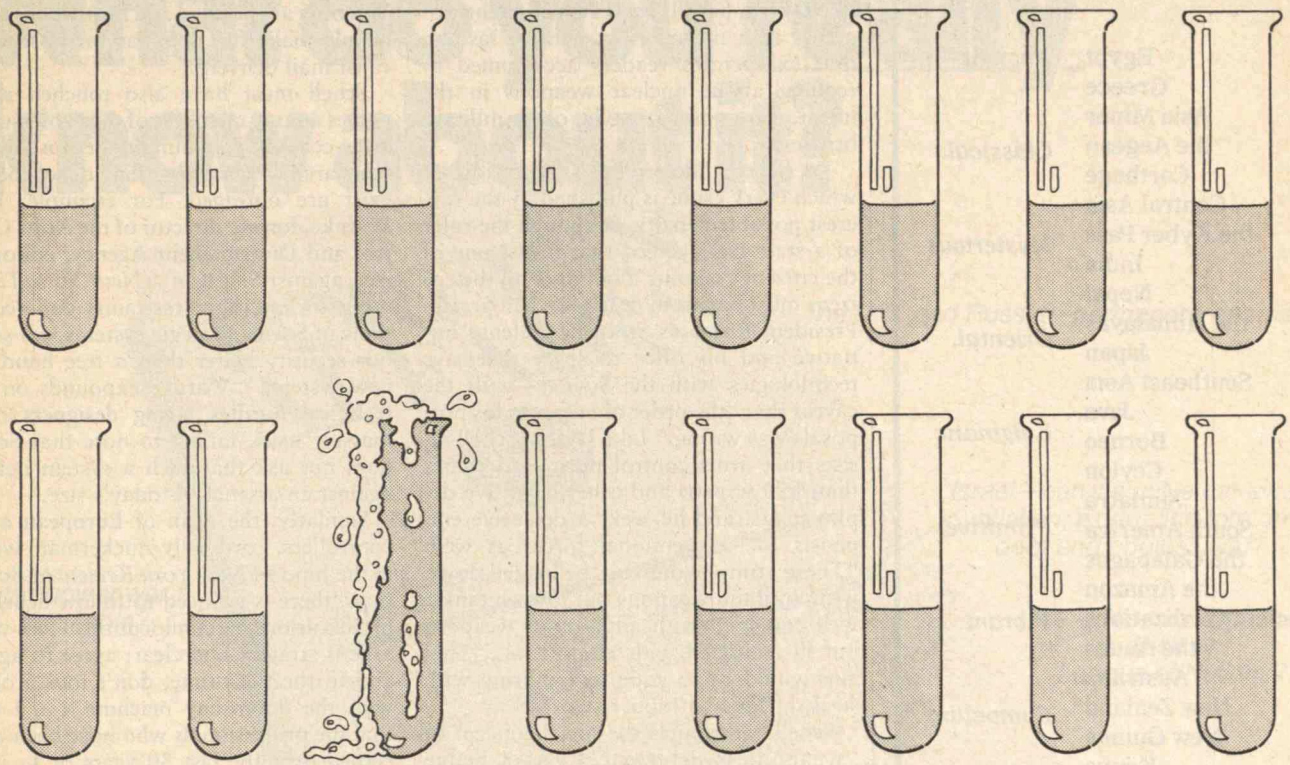
Weaponless Deterrence

In *The Abolition*, Jonathan Schell comes to conclusions much like Dyson's from a drastically different perspective. Schell agrees with Dyson that we can't prove we do have the ability to make the human race extinct and that we can't prove we don't. But Schell regards the mere capability that we *might* to be the central, historically unique fact of the contemporary human condition. Schell's previous book, *The Fate of the Earth*, was a cry of alarm at the peril of nuclear extinction. He received thousands of letters and phone calls from concerned readers asking him what they could do about the threat, and many people credit Schell with a major role in energizing the nuclear freeze movement. But Schell sees that movement as largely symbolic, so he wrote *The Abolition* to present a concrete alternative to mutually assured destruction.

Schell has a flair for the unforgettable metaphor, stringing together images in long sentences and interminable paragraphs that work surprisingly well. And,

ILLUSTRATION: KEN GOLDSTROM

What makes our science park so different from the others?



To start with, ours is in Scotland, a country with a world-wide reputation for innovation and development.

Where the new technologies have taken root at an astonishing rate.

Where more silicon chips are manufactured per capita than in Japan.

And where more graduates are produced per capita than in any other country in Europe.

Better still, the West of Scotland Science Park has been established by the Scottish Development Agency and not just one, but two of Scotland's leading universities, Glasgow and Strathclyde.

Their research teams already work so closely with industry that much of what they innovate goes straight into production.

From oscillating quartz deposition monitors for measuring and controlling thin film thickness on optical and semi-conductor components to human monoclonal antibodies for commercial applications.

The West of Scotland Science Park is a catalyst bringing academics and industrialists into closer collaboration than ever before.

Both universities provide direct access to their senior staff, their laboratories, their libraries, their computer systems and their business schools.

Park Management provides all the necessary introductions, together with something you may not find on other science parks.

Commitment.

We are dedicated to making your involvement here an outstanding commercial success.

A fact clearly evident in the special environment we have created on the Park itself.

Where acres of mature woodland, meadows and riverbank surround low-density advance units.

And where premises can, if the need arises, be custom-built.

Indeed, the whole setting is more like a country estate than an industrial estate.

Yet it's only 20 minutes from Glasgow city centre and Glasgow Airport.

So if you're in high tech, whether R and D or manufacturing, and you're looking for the best place for your business to grow, well – congratulations.

You've just found it.

Now come and see it.

You'll soon understand why we're bubbling over with enthusiasm.

WEST OF SCOTLAND

SCIENCE PARK

Contact: Dr Colin Bond at 1.01 Kelvin Campus, West of Scotland Science Park, Glasgow G20 0SP. Tel. 041-946 7161.

like Dyson, Schell weaves his thoughts together in a meandering, parallel fashion that exasperates readers accustomed to reading about nuclear weapons in the linear, no-nonsense style of a military briefing.

To Schell, "deterrence is a regime in which every crime is punished by the severest possible penalty, as though the ruler of a state has decreed that if just one of the citizens commits a burglary all the citizens must be put to death." Schell praises President Reagan's Strategic Defense Initiative and his offer to share defensive technologies with the Soviets—with the caveat that "the order of events in his proposals was wrong." Like Dyson, Schell insists that arms control must lead rather than follow BMD and other defensive deployments, and he seeks a defensive emphasis for conventional forces as well. "These armies would . . . be loaded down with antitank weapons but low on tanks; well equipped with antiaircraft weapons but ill equipped with aircraft. . . . [The] aim would be to equip every army with steel shields and rubber swords."

Schell contributes the novel concept of "weaponless deterrence." As a hedge against a "blatant, open violation of an agreement [to ban nuclear weapons] by a powerful and ruthless nation," Schell proposes that nations maintain the knowledge and facilities to regenerate nuclear weapons and their delivery systems in the event such cheating is detected. "The knowledge of how to rebuild the weapons is just the thing that would make abolition *possible*, because it would keep deterrence in force. Indeed, the everlastingness of the knowledge is the key to the abolition of nuclear arms." Weaponless deterrence actually worked successfully during World War II, when both sides decided not to deploy chemical and biological weapons for fear of the mutually catastrophic results.

Given these authors' radically different backgrounds, might not the similarities in their thinking be due to the nature of the nuclear problem itself? Yet even though the strategic defense community has accorded Dyson's analyses an open-armed acceptance, it has responded guardedly, sometimes with hostility, to Schell's. This difference may stem from the contrasting assumptions of the two authors. For many people working on defense, retaining their mental health means remaining cheery about nuclear war; they make it an article of faith that something has got to survive. Warriors are puzzled and hurt when freeze people make fun of plans for post-holocaust mail delivery.

Schell must have also touched some nerves among members of the professional arms-control community, because those who aren't trying to pretend he doesn't exist are outraged. For example, Paul Warnke, former director of the Arms Control and Disarmament Agency, editorialized against Schell in a *New York Times* book review that "restraints and reductions in Soviet strategic systems will serve our security better than a free hand for new systems." Warnke expounds on the technical hurdles facing designers of a massive BMD, failing to note that Schell does not ask that such a system defend against an arsenal of today's size.

Similarly, the dean of European arms controllers, Lord Solly Zuckerman, wrote in the June 14 *New York Review of Books* that "there is no need to follow Schell in his luxurious circumlocutions. His message is straight and clear: agree to agree, and in the meantime, don't fool around with the doomsday machine. . . . I fear that the professionals who have been concerned over the last 30 years or so with the problem of reaching agreement will not find any new guidance in what he has to say." How could Zuckerman confuse Schell's dramatic proposals for BMD and weaponless deterrence for some weak-kneed suggestion that the United States and the Soviet Union should "agree to agree"?

But where Zuckerman simply waves away Schell's ideas, he reacts defensively to Dyson's. Perhaps this is because both he and Dyson have been prominent scientific advisors long concerned with reducing the nuclear threat. "Is it conceivable," Zuckerman asks, "that Freeman Dyson does not know that the problem of creating an effective non-nuclear defense has been in the forefront of NATO discussion from the start? . . . And that nothing has changed? . . . What have successive presidents, prime ministers, chancellors, and Politburo members been trying to do these past 30 years?" Perhaps the pride of the arms-control professionals may actually be wounded if newer ideas succeed where theirs have failed. But that may very well happen. □

CAROLYN MEINEL is a staff scientist at Analytic Decisions, Inc., a think-tank in Arlington, Virginia.

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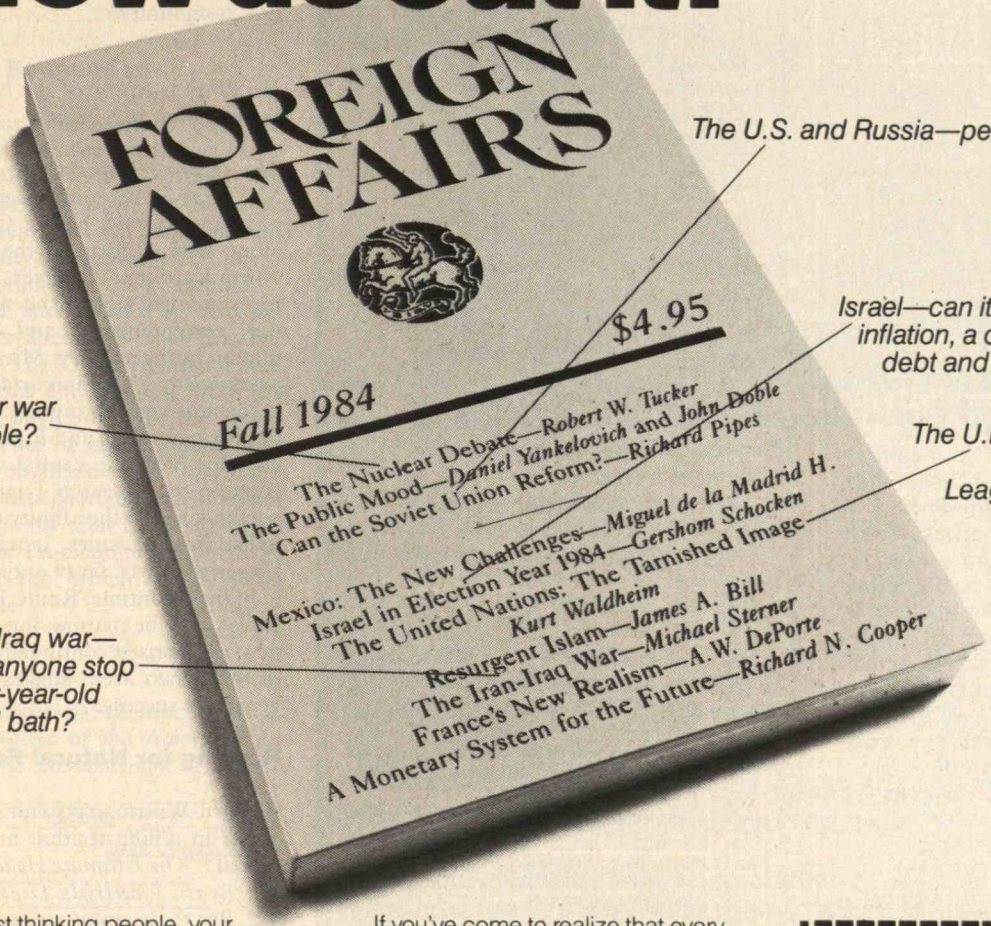

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Continued from page 6

United States, we're confident that that, too, will soon appear. Delegations from other states and countries tour Route 128 and Silicon Valley to see mature high-tech areas, but they come to North Carolina to see a mecca in the making.

Jeri Gray
Raleigh, N.C.

Jeri Gray is editor of the North Carolina State alumni magazine.

The author responds:

Ms. Gray is of course correct. I should have mentioned North Carolina State along with Duke and the University of North Carolina. However, I will stand by my statement about the relative lack of new entrepreneurial and corporate formation in the area. As Ms. Gray woefully acknowledges, an important missing ingredient is venture capital, which is essential for new firms and for firms that must expand. Venture capital may someday come to the Research Triangle, but I suspect that, given the affinity of venture capitalists for big cities, it will take a little longer than Ms. Gray anticipates.

In the meantime, Route 128 and Silicon Valley may be mature, but the number of new enterprises continually springing up in those two areas suggests that success generates success.

Rooting for Natural Food

Richard Wurtman's swipe at health-food stores in selling lecithin may be well-deserved (*"The Ultimate Head Waiter: How the Brain Controls Diet," July, page 42*). But these stores serve a vital function in leading people to use natural foods, such as whole-grain products. The use of white bread, for instance, is an offense against nature and results in all manner of serious deficiencies. We cannot stray so far from the coarse foods we evolved on without dire consequences.

In *Anatomy of an Illness*, Norman Cousins states that homeostasis cannot prevail if the body is not treated naturally. Natural treatment means sensible nutrition, relief from excessive stress, and positive mental and spiritual factors. Cousins adopted such a program and was cured of a supposedly fatal collagen disease.

I had many severe disorders, culminating in a heart attack at age 57. The doctor who treated me said my heart was wearing

out. I adopted natural procedures and recovered completely. Now at age 88 I indulge in all the activities the doctor warned against: swimming in the ocean, climbing hills, rowing boats, shoveling snow.

Albert J. Pyle
Wilmington, Del.

Household Economics

One economist who properly integrates the household into the operation of the economy is Wassily W. Leontief, who builds it into the input as well as the output side of the system. Richard Stone, at Cambridge University, has done the best micro-input/output studies of the household.

Both would undoubtedly be delighted to help further document what Rosalind Williams, in "The Other Industrial Revolution: Lessons for Business from the Home" (*July, page 30*), calls the economy's "dependence on housekeeping, both familial and environmental." Actually, Leontief has also charted environmental costs in detail in the table he set up for the Environmental Protection Agency more than a decade ago, which is presumably kept up to date.

Gerard Piel
New York, N.Y.

Mr. Piel is publisher of Scientific American *and president-elect of the American Association for the Advancement of Science.*

U.S. POSTAL SERVICE
STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

1. TITLE OF PUBLICATION	A. PUBLICATION NO.	2. DATE OF FILING
TECHNOLOGY REVIEW	0 0 4 0 1 6 9 2	September 29, 1984

3. FREQUENCY OF ISSUE	A. NO. OF ISSUES PUBLISHED ANNUALLY	B. ANNUAL SUBSCRIPTION PRICE
8 ISSUES PER YEAR Jan, Feb/Mar, Apr, May/Jun, Jy, Aug/Sep, Oct, Nov/D	8	$24.00

4. COMPLETE MAILING ADDRESS OF KNOWN OFFICE OF PUBLICATION
10-140 MIT, 77 Massachusetts Avenue, Cambridge, Mass. 02139

5. COMPLETE MAILING ADDRESS OF THE HEADQUARTERS OR GENERAL BUSINESS OFFICES OF THE PUBLISHERS
10-140 MIT, 77 Massachusetts Avenue, Cambridge, Mass. 02139

6. FULL NAMES AND COMPLETE MAILING ADDRESS OF PUBLISHER, EDITOR, AND MANAGING EDITOR (This item MUST NOT be blank)

PUBLISHER (Name and Complete Mailing Address)
William J. Hecht, 10-110 MIT, 77 Massachusetts Avenue, Cambridge, Mass. 02139

EDITOR (Name and Complete Mailing Address)
John I. Mattill, 10-140 MIT, 77 Massachusetts Avenue, Cambridge, Mass. 02139

MANAGING EDITOR (Name and Complete Mailing Address)
Peter Gwynne, 10-140 MIT, 77 Massachusetts Avenue, Cambridge, Mass. 02139

7. OWNER

FULL NAME	COMPLETE MAILING ADDRESS
Alumni Association of the	10-110 Alumni Center
Massachusetts Institute of Technology	77 Massachusetts Avenue
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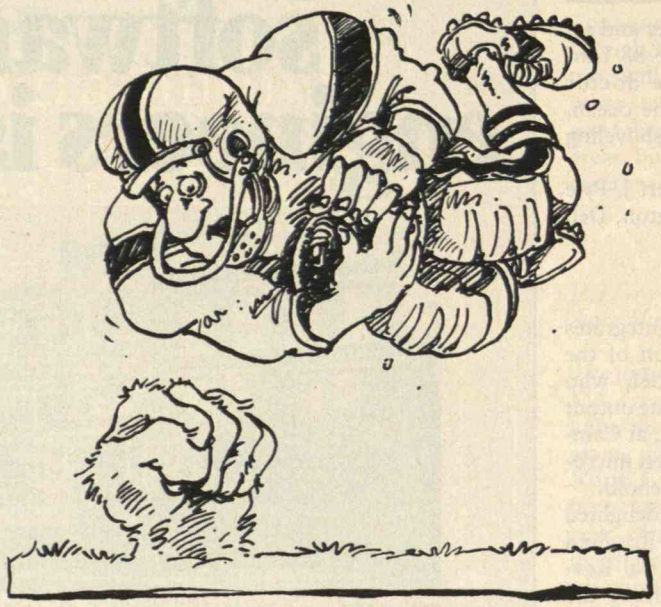
PS Form 3526, June 1981 (See instruction on reverse) (Page 1)



The Safety of Phony Turf

The Ford Foundation commissioned a study in the 1960s to determine why urban children were consistently scoring lower on physical-fitness tests than their suburban counterparts. The commission concluded that inner cities lacked suitable playing surfaces and proposed devising an artificial grass for use on parking-garage roofs, concrete playgrounds, and other sites in the urban jungle. Manufacturers took up the call to produce synthetic turf, and in 1964 the first field made of plastic was installed at the Moses Brown School in Providence, R.I.

When the Astrodome was completed in Houston two years later, the managers decided that they wouldn't be able to coax natural grass to grow, so they too installed synthetic turf. During that baseball season the term "AstroTurf," taken by Monsanto as a trade name, entered the popular lexicon. Synthetic turf has since been used widely on professional fields, especially in the new domed stadiums. But is this playing surface safe?

Critics argue that its hardness—it is generally laid on gravel, asphalt, or concrete—may cause or aggravate sports injuries. Constant pounding on the hard base leads to fluid buildup in the knee, ankle, and hip joints, says Steve Garland, team trainer for the New York Mets, a team with natural grass on its home field. The Montreal Expos' André Dawson enjoys legendary status as a baseball player whose career has been limited by phony turf (as it is called by sports aficionados). The theory is that chasing balls on this hard surface at Olympic Stadium has aggravated the arthritis that afflicts Dawson's knees.

The pounding and fluid buildup may also impair the healing process after a player is operated on for an injury, or even cause a relapse of the original problem, says Garland. And then there is "turf toe," a painful hyperextension of the tendons and ligaments leading to the toes. Physicians say that it is caused when athletes' feet push against the synthetic turf's unforgiving base.

Artificial grass has also spawned more esoteric injuries. Many players complain of "rug burn"—abrasions and cuts caused by sliding across the stiff blades of plastic grass. Rug burns look clean because there is no visible dirt in synthetic turf. However, they can cause infections because of germs from players' spit, sweat, and blood.

The problems with cuts and infections have been the easiest to address. Players scrub themselves after games on artificial turf with an iodine soap and wear protective gear. Also, "nondirectional grass" has been introduced to reduce the severity of scrapes. The blades of previous generations of artificial turf tended to fall in a particular direction, and athletes received their worst burns by scraping against the grain.

For 20 years manufacturers have striven to make their surfaces "fluffier" to reduce the hardness. Monsanto, the leading manufacturer, now places a 5/8-inch polyurethane pad on top of a gravel and asphalt base. Above this is a rubber carpet with plastic blades of grass. Monsanto says its layer-cake playing surface is no more hazardous than natural grass. "Shock absorbency" (the company says "hardness" is a subjective concept), as measured by a deadweight attached to electronic sensors and dropped from a tripod, is as much as 40 percent better than on natural grass.

Deadweights notwithstanding, playing on synthetic surfaces remains football players' most common safety complaint. The National Football League (NFL) Players Association asked for a moratorium on synthetic-turf installations as part of its latest collective-bargaining proposal, and the players association has three times asked the U.S. Consumer Products Safety Commission (CPSC) to declare synthetic fields hazardous.

Three times the CPSC has declined, saying the medical data are inconclusive. Monsanto points out that a 1979 study based on the National Athletic Injury/Illness Reporting System showed no significant difference between playing on synthetic and natural fields. However, a 1970 study conducted at Stanford University under the guidance of Dr. James Garrick, an advisor to the NFL's player-management safety committee and director of the Center for Sports Medicine at Saint Francis Hospital in San Francisco, was critical of synthetic turf. Still, Garrick admits that the causes of football injuries are so varied that gauging the significance of artificial turf is not yet possible.

Fast Grass

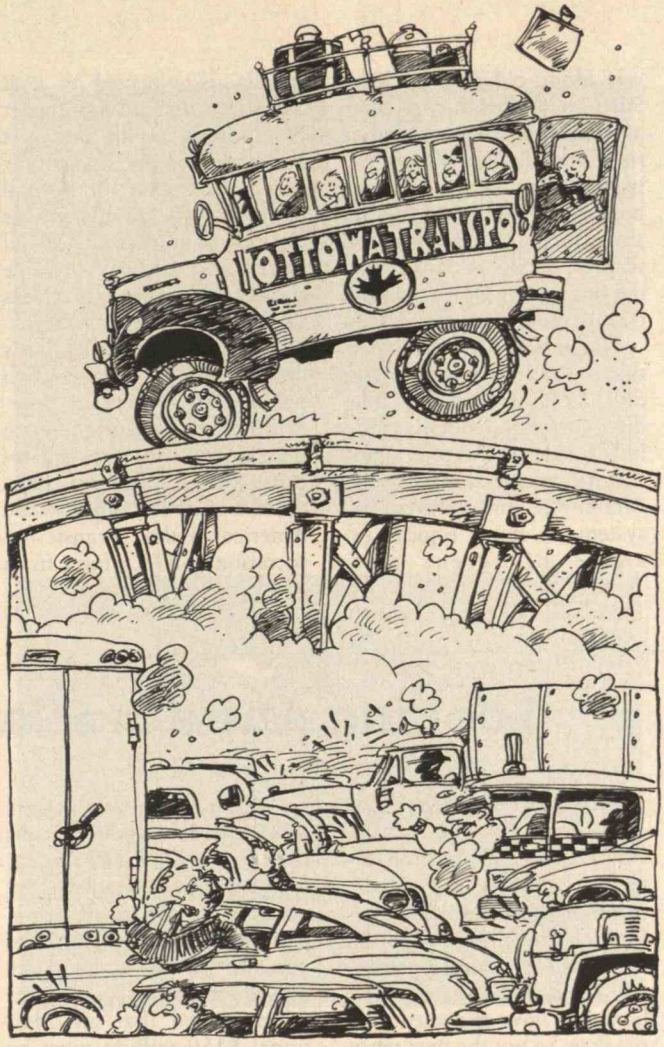
The latest concern over artificial turf has to do with what Garrick calls "foot fixation." As turf manufacturers tell customers, traction is much greater on synthetic playing fields than on fields planted with grass, and this allows players to start, run, and turn faster. If players are running faster, Garrick suggests, they're also hitting each other harder and are therefore more likely to sustain serious injuries. However, this hypothesis has not been proven, Garrick cautions, and it doesn't nec-

essarily account for injuries that involve no collisions, such as the twisted knee suffered by Seattle Seahawks' star running back Curt Warner earlier this season.

While conceding that the speed factor could pose safety questions, supporters of synthetic turf still doubt that it has made sports more dangerous overall. Dr. James Nicholas, team doctor for the New York Jets, reminds his players that football on natural surfaces has not always been as idyllic as synthetic-turf critics might imply. "I can remember games in Denver in December where we had 17 men hurt," Nicholas says. "I can understand the players' complaints, but they have to prove their case."

Even if turf manufacturers should try to reduce traction on their fields, Garrick says their efforts would be undone by shoe manufacturers. Pepper Burris, team trainer for the New York Jets, explains that "it's gotten to the point where our players are like Mario Andretti," drawing a parallel with auto racing. "No matter what kind of weather on the track, Andretti has tires to make his cars faster. No matter what the conditions of the field, we have shoes to make the players run faster."

Twenty years after the Ford Foundation study, synthetic turf is increasingly being used on some high-school and college fields—and the safety issue is assuming new importance. Garrick believes that four to eight years' additional play on synthetic turf may make athletes more likely to suffer serious injuries. Mets trainer Steve Garland agrees. He fears that the knee and ankle joints may be threatened while still developing in teenaged bodies.—*Joel Millman* □



Ottawa Builds a Busway

Most recent mass-transit systems in the United States have been high technologists' dreams. Planners have embraced subway trains directed by computers, vehicles engineered by aerospace firms, and magnetic cards for tallying riders' fares. However, turning these dreams into reality has brought surprises. In San Francisco's BART system, the computers intended to direct trains detected "phantoms," and management finally had to hire human drivers. The sophisticated doors on new cars in Boston had more than a thousand moving parts, but they sometimes failed to fulfill their basic purpose—to open at stations and stay closed between them. The subway in Washington, D.C., did attract new riders to public transportation—but at a cost of $10 a ride, according to the Urban Mass Transit Administration.

Wary of this record, some cities are turning to more mundane schemes to improve mass transit. Pittsburgh operates some 11 miles of busway—roads used exclusively by buses—and several other U.S. cities, including Baltimore, Houston, and Seattle, are exploring the idea. But Ottawa, Canada, is embarking on by far the most ambitious effort.

On and Off the Busway

By 1991, Ottawa will have built about 20 miles of its Transitway, a two-way road system for buses snaking through the city, separated from other traffic. The Transitway will have 4 main arteries with 38 stations; 6 miles of road and 10 stations have already opened. Buses collect riders on city streets and enter the Transitway, where they stop only at stations. Most of them then return to the city streets to discharge passengers going to destinations that are distant from the Transitway.

The Transitway is intended to provide particularly efficient transportation for commuters. When the system is complete, buses will pick up passengers in the suburbs just as they do now, then enter the Transitway at the city's edge and run express downtown, escaping urban bottlenecks. On some of the busier routes, tandem buses will provide more capacity. The significant advantage of such a system, says Jose Gomez-Ibañez, a transit economist at Harvard, is that one vehicle can provide integrated service—suburban collection, express travel, and downtown distribution.

The Transitway should streamline Ottawa's already popular bus system. Today passengers can find a stop within a quarter of a mile of any point in the city. Planners at Transpo, the transit authority, used information from rider surveys to establish a multiplicity of routes

ILLUSTRATIONS: JON MCINTOSH

that enables more than 90 percent of the riders to reach their destinations without a transfer. A bus system allows much more flexibility in laying out routes than a train system, notes Helen Gault, director of system planning for Transpo. The Transitway is intended to preserve that flexibility. The section that is already open has allowed Transpo to reduce its bus fleet by 4 percent, and Gault estimates that the complete system will decrease travel times by an average of 12 percent.

To hold costs down, engineers put part of the Transitway along old railroad lines. Such an opportunity is often available in cities, according to Gomez-Ibañez. Other sections of the Transitway will be laid on little-used city streets, and still other sections will run on rights-of-way that the city already owns, frequently beside existing roads.

Planners at Transpo expect that the entire system will cost only $235 million in Canadian currency (roughly $180 in U.S. currency at today's exchange rates). In contrast, Miami's 22-mile elevated-rail system—a more typical example of recent mass transit—is expected to cost $1 billion. Furthermore, part of Ottawa's capital cost is a hedge in case the Transitway is too successful: for a small premium, the roadway was engineered so that a light-rail system could be put in place should the volume of riders exceed the buses' capacity.

Revenues from Ottawa's new system are expected to pay for 70 percent of operating costs—another figure that is extraordinary by recent North American standards. According to the American Public Transit Association (APTA), fares from U.S. systems average less than 40 percent of operating costs.

Ottawa's promising approach seems to be making inroads into the U.S. transit community's traditional insistence that good transit means rail transit. "To be building a bus system on a separate grade from city streets—without the capital costs of rail but engineered so that rail could be put in—is a very good thing," says Jack Gilstrap, executive vice-president of APTA. "I just wish we could see more of the concept implemented in the States."—*David Kennedy* □

Looking Anew at *Silent Spring*

In the 20 years since Rachel Carson's untimely death, how much have we learned from her invocation of Keats' dismal vision of a spring without bird songs?

A great deal, is the obvious answer. Perhaps the greatest tribute to *Silent Spring* is that the tragedy Carson predicted has been averted. DDT and the other long-lived chlorinated insecticides that she warned about are banned in the United States. Species of hawks, reptiles, and fish once driven nearly to extinction are returning. The Environmental Protection Agency (EPA) and the plethora of regulatory acts it enforces are secure, although perhaps not aggressively prosecuted under the Reagan White House. Even the American Chemical Society's Division of Pesticide Chemistry, the professional organization of those who design, produce, and market 750 million pounds each year of insecticides, herbicides, and rodenticides, paid its tribute last fall on the twentieth anniversary of Rachel Carson's death.

But the confrontation between humans and nature through pesticides is not over. Though the planners of the American Chemical Society's Carson anniversary symposium may have expected their speakers to use the past tense, most did not. The basic message of *Silent Spring*—Carson's "questioning the whole attitude of industrial society toward the natural world," in the words of her biographer Paul Brooks—remains as pertinent today as in 1962.

A Mixed Record

Though the use of persistent chlorinated pesticides is minimal in the United States, the total consumption of all pesticides is higher than ever, and on average today's pesticides are more potent than their predecessors, said entomologist David Pimentel of Cornell University. The widespread use of such agents inevitably destroys organisms that are not intended targets. Many of these organisms are natural predators of pests, and when the predators decline in number, the pests only increase further. Pimental estimated that an additional $150 million must be spent each year to destroy pests because of this effect. He estimated that another $120 million is added to annual pesticide bills because pests develop resistance to low doses of poisons, and that $135 million worth of each season's harvest is lost because pesticides kill some of the bees that pollinate crops.

Persistent chlorinated pesticides no longer threaten wildlife, said Russell J. Hall, director of the U.S. Fish and Wildlife Service's research center at Patuxent, Md. But every year there are "significant episodes" of wildlife being poisoned by other pesticides. Even more birds are undoubtedly lost in their migration and winter habitats, because the Third World still makes extensive use of pesticides banned in the industrialized nations.

Those who live in industrialized nations shouldn't be too quick to criticize this practice, cautioned Professor John E. Davies of the University of Miami's Department of Epidemiology and Public Health. Risks and benefits must be balanced differently in a nation on the edge of famine. Without the pesticides now used, Davies estimated, Third World nations' food production would be reduced by 9 percent, and another 9 percent of their food would be lost in storage.

But the price of this 18 percent gain is high. It includes 11,800 people sick from pesticide poisoning in Sri Lanka in 1980, Davies said, and 120 deaths in Trindad in 1983, according to Rohit Doon of Trinidad's Ministry of

Health. In all, according to Pimentel's estimates, an average of 45,000 humans are poisoned by pesticides each year.

Knowledge about many of the important impacts of pesticides remains scant, said Pimentel. Scientists know and care too little about how pesticides affect species that are not their targets—thousands of beneficial creatures such as bees and countless invertebrates and microorganisms that perform vital functions in the environment.

A more fundamental complaint came from Pimentel's Cornell colleague Christopher F. Wilkinson. Investigations into the effects of pesticides still contain a "black box," he maintains: little is known about how these chemicals physiologically affect living organisms. Thus, it is hard to tell what new agents will do before they are tested.

The EPA's John A. Moore looked on the brighter side of the pesticide issue. He is particularly captivated by the last chapter of Carson's *Silent Spring*—her confidence that there are "new, imaginative, and creative approaches to the problem of sharing our earth with creatures." That's still true, said Moore: "The next decade will be the domain of biotechnology." By finding out more about an organism's genes, chemists will be able to craft a pesticide specifically to affect that species—even in a single stage of its development. Thus, the road ahead, Moore said, demands a still better understanding of both the species themselves and the agents with which to combat them.—*John Mattill* □

Large numbers of birds such as this osprey (top) have been killed by DDT. Since the pesticide was banned in 1972, the average number of chicks born to nesting ospreys has tripled (middle). Snowy egrets are now nesting in New England (above), expanding their range from the South.

Gene Therapy: The Human Trial

Lesch-Nyhan syndrome turns children into profoundly retarded cripples who have to be restrained from biting themselves to shreds. This disease is caused by the lack of a normal gene and, like all other genetic disorders, is at present incurable. However, researchers believe that by using techniques that can, in effect, change the leopard's spots, they will soon be able to give patients new genes and cure some of these diseases once and for all. The first approved trial of such gene therapy on a human being may be less than a year away, according to Dr. W. French Anderson of the National Institutes of Health (NIH).

"Approved" is the key word. In 1981 Dr. Martin Cline of the University of California at Los Angeles was disciplined for having tried to use gene therapy to treat two patients severely ill with thalassemia, a genetic form of anemia, without proper authorization from UCLA review panels. Cline inserted a gene for making the normal hemoglobin that these patients lack into the bone marrow, where blood cells are made. Animal tests of the technique had failed and, predictably, so did the human trial, though it caused no harm. Before embarking on human trials of gene therapy, federally funded scientists must now receive permission from both the Recombinant DNA Advisory Committee

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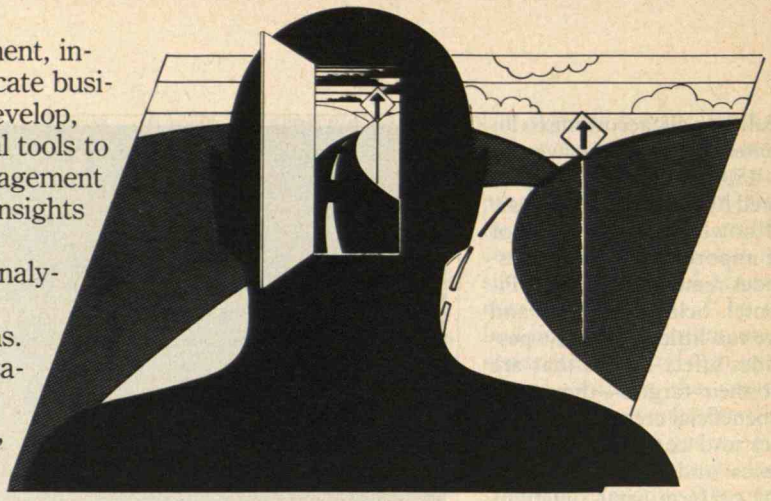

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This baby has severe combined immune deficiencies syndrome (SCIDS), a genetic disorder that leaves victims vulnerable to infection. Within a year gene therapy may be used in an attempt to cure some forms of SCIDS.

(RAC) of the NIH and the U.S. Food and Drug Administration (FDA).

The choice of thalassemia as the first disease to treat using this approach to gene therapy was a dubious one. It is true that the gene needed to produce normal hemoglobin has been identified—an important prerequisite. Some common genetic disorders cannot be tackled yet because scientists do not know which gene is needed to cure them. One of these diseases is cystic fibrosis, which, among other things, makes the victim's lungs susceptible to infection. But the trouble with attempting to cure thalassemia is that the needed gene is regulated in complex and poorly understood ways by other genes. Besides, thalassemia, along with hemophilia, is among the few serious genetic disorders that can be treated fairly effectively.

The earliest approved trials of gene therapy will undoubtedly be for disorders that cannot be treated in any other way, or at least for those that could probably be treated more effectively with gene therapy. Also, the FDA and RAC are sure to veto any gene therapy that would affect sperm or egg cells—and therefore future generations.

Which Disease?

The diseases that are the most likely candidates for initial trials are adenine deaminase deficiency (ADA) and purine nucleotide phosphorylase deficiency (PNP), both of which leave patients highly vulnerable to infection. ADA and PNP are among the genetic abnormalities that make infants into "bubble babies"—so called because of the sterile chambers they must live in.

Victims can be given bone-marrow grafts from healthy donors. When the treatment is successful, the normal bone-marrow cells divide and multiply, producing blood cells that are able to fight infection. However, the transplants are sometimes rejected by the body or turn on the patient's tissue, producing the usually fatal illness called "graft-versus-host" disease. If the patient's own marrow could be given the normal

Continued on page 77

Which Genetic Diseases Can Be Cured?

People generally have two genes for any given trait. Either of these genes may be "dominant," meaning that it "codes"—provides a blueprint—for a protein that affects the trait. Either of the genes may also be "recessive," meaning that it does not code for that protein.

For example, brown eyes are produced by brown-pigment protein, and blue eyes are produced by a lack of that protein. Thus, the dominant gene codes for the brown pigment and produces brown eyes. The recessive gene does not code for this pigment; anyone with two recessive genes lacks the pigment and hence has blue eyes. However, anyone with one dominant gene and one recessive one does have the pigment and therefore has brown eyes.

If brown-eyed parents have a blue-eyed child, it is generally because both of them had one recessive (blue-eye) gene and passed it along to their offspring. Alternatively, the blue-eyed child of brown-eyes parents may owe that trait to a mutation.

About 2,000 human disorders are likewise conferred by either a pair of recessive genes—but in this case abnormal ones—or a mutation. Some sex-linked diseases that afflict males almost exclusively, such as hemophilia and Lesch-Nyhan syndrome, come about somewhat differently. The genes are packaged in larger units known as chromosomes. A woman has two "X," or female, chromosomes, and if there is a recessive, abnormal gene on one or both of them, she can transmit it to her son. Because he is male, he will have only one X chromosome, which he will get from his mother. Thus, no normal gene in another X chromosome will be available to counteract the abnormal one. He will have the disease even if she does not.

In any case, lack of a normal gene in a patient with one of these 2,000 or so "recessive" disorders means that the patient is missing a needed protein. The absence of that protein sets off a chain reaction of chemical disturbances. Depending on the gene in question, these disorders vary from trivial to lethal.

If one normal gene is given to cells such as those of the bone marrow, they and their descendents should copy the needed gene, which will, in turn, supply the missing protein. That is how researchers hope gene therapy will work.

However, in some genetic disorders—Huntington's disease, for example—the harmful gene does not fail to code for a normal protein but does in fact code for a protein that is damaging. Curing such a disease would require turning off production of the protein or removing the gene, and unfortunately, researchers have no idea how to accomplish those tasks. They also do not have a clue to how to cure diseases such as Down's syndrome (mongolism) that are caused by entire chromosomes gone awry.—*J.E.R.*

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Continued from page 75

gene, these reactions presumably would not occur.

Another candidate for gene therapy is Lesch-Nyhan, which occurs when a patient lacks the gene to produce one of the enzymes needed to break down uric acid. Uric acid is one of the compounds produced in digesting food, but when it accumulates it becomes toxic. Bone-marrow cells obtained from Lesch-Nyhan patients and treated in the laboratory with the needed gene have produced the missing enzyme. Thus, doctors hope that if they return treated marrow to the patients, it will continue to produce this enzyme.

No matter which disease is selected, patients treated with gene therapy may face a significant danger. So far, the most efficient vehicle available for getting a new gene to bone-marrow cells is a retrovirus—a bundle of genetic material that can enter a cell and alter its genetic makup. Unfortunately, retroviruses can cause tumors unless properly altered.

An M.I.T. team led by Richard Mulligan, together with Dr. David Nathan at the Children's Hospital Medical Center in Boston, has devised an ingenious way to cripple retroviruses once they deliver the desired normal gene. However, researchers remain concerned that the defanged retroviruses may nonetheless activate the patient's oncogenes—genes present in all cells that are thought to cause cancer if stirred from their normally dormant state. Ruling out this possibility is no easy task.

A Hard Decision

Because of the possible dangers, proposals to apply gene therapy will be controversial, and Nathan is skeptical about trying it on Lesch-Nyhan patients. He doubts that gene therapy can reduce the high levels of uric acid in the brain—the step that must be taken to moderate a patient's mental retardation and self-mutilation.

The so-called blood-brain barrier, which permits only selected substances to enter the brain, might exclude the gene needed to break down uric acid and cure Lesch-Nyhan. Even if the gene could be transported into brain cells, most of them do not divide and produce copies. Thus, the gene could not be reproduced in quantities sufficient to have much effect. If other cells in the body are given the gene and produce the needed enzyme, it too might not be able to cross the blood-brain barrier. And if it does, the brain cells might not make use of it, or might not obtain enough to reduce uric-acid levels significantly.

Nathan does not think gene therapy should be attempted on Lesch-Nyhan patients unless bone-marrow transplants are tried first and show some signs of success. However, Dr. Jarvis E. Seegmiller of the University of California at San Diego and his colleagues there and at the Salk Institute in La Jolla, who are immersed in an effort to cure Lesch-Nyhan, think Nathan may be overstating the risks of going directly to gene therapy.

After thrashing out the arguments pro and con, officials at the FDA and NIH will have to decide whether to let doctors try to cure Lesch-Nyhan—and other diseases—with gene therapy. Up to 50 percent of the patients admitted to children's hospitals have problems of genetic origin. Thus, if it proves successful, gene therapy would indeed be a breakthrough in the true sense of that overused term. But gene therapy is a venture into the unknown, and as such is attended by some hazards.

—Judith E. Randal □

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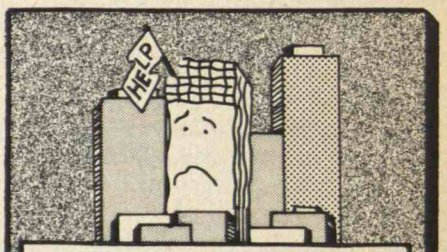

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MEDICAL TECHNOLOGIES

Continued from page 18

the beneficiaries of new transplant technologies. At present, patients with families who know how to attract publicity and can afford the steep price of transplantation are often the first chosen for available liver and heart donations. While total expenditures for organ replacement should be a matter of social policy, ability to pay should in no way affect the decision to replace a failing organ. The choice should be based strictly on medical need and the likelihood of beneficial results. This means taking into account the cause of organ failure, the age of the patient, the availability of a suitable donor, and the ability of the patient to recover. For example, a good candidate for a heart transplant would be a previously healthy young adult, with a supportive family, who has a terminal heart disease that is unresponsive to therapy. Hospitals' patient-selection committees should include representatives from various health professions and sectors of society, including educators, clergy, business leaders, labor leaders, and consumers.

Future decisions about organ replacement, or any new technology for that matter, will be better informed if we assess short-term and long-term clinical results as well as the costs to society. At present such studies are not being adequately funded, even though they offer the only prospect for reducing uncertainty about new medical technologies.

Policymakers will always have to contend with conflicting health and social objectives: the desire to provide the most sophisticated type of care possible versus the obligation to contain costs; the tendency to support the visible and glamorous products of technology versus the need for a more preventive and widely beneficial approach. If consumers and policymakers can attain more flexible control over the allocation of health resources, they will be better able to balance these forces and perhaps provide higher-quality care for more Americans.

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Scrubber Deficiencies

Most of us know that scrubbers are used to remove acid-rain-causing sulfates from the flue gas of coal-fired furnaces. But even experts disagree on how well scrubbers do this job, and on how much they add to the cost of the energy from the furnaces.

After a two-year study of scrubber systems on 26 power plants with an average capacity of 360 megawatts, Jean Tilly of the M.I.T. Energy Laboratory confirms the uncertainties. Among Tilly's results:

□ Scrubber systems for new plants cost on average $150 ± $30 per kilowatt hour of capacity, retrofitted systems $180 ± $60. This means that a scrubber system can add up to 25 percent to the base cost of a generating station.

□ The average operating cost of a scrubber system is 1 cent ± 0.3 cents per kilowatt-hour; scrubbers thus add roughly 20 percent to the price of electricity. But the cost is actually higher, because of debt service on the extra original investment, and because a scrubber consumes 1 to 6 percent of a plant's total electric output.

□ Scrubber systems on new plants operate about 95 percent of the time; retrofit installations average 83 percent "up" time. Scrubbers theoretically remove from 50 to 90 percent of the sulfates in stack gas, depending on the installation. However, given the downtime implied above, scrubbers may remove at best between 40 and 80 percent of a combustor's sulfates.

Clearly, says Tilly, the technology needs further development if scrubbers are to be a major strategy for mitigating acid rain.□

Age as an Asset on the Job

Though they may have very little correlation with actual job performance, age and seniority have a lot to do with the way people think about themselves and others on the job.

Seniority—independent of merit—has a larger role in promotion decisions than most personnel managers admit, say Katharine G. Abraham of M.I.T. and James L. Medoff of Harvard. And many people consider age an "implicit career timetable" against which to measure success, says Barbara S. Lawrence of M.I.T.

Abraham and Medoff say their survey of a large number of U.S. firms shows that perhaps 60 percent of employees work in settings where seniority leads to a substantial preference—more than is reflected in any policy statements—in promotion decisions. And it happens to both union and nonunion employees, a finding that calls into question the idea that unions constrain promotion decisions.

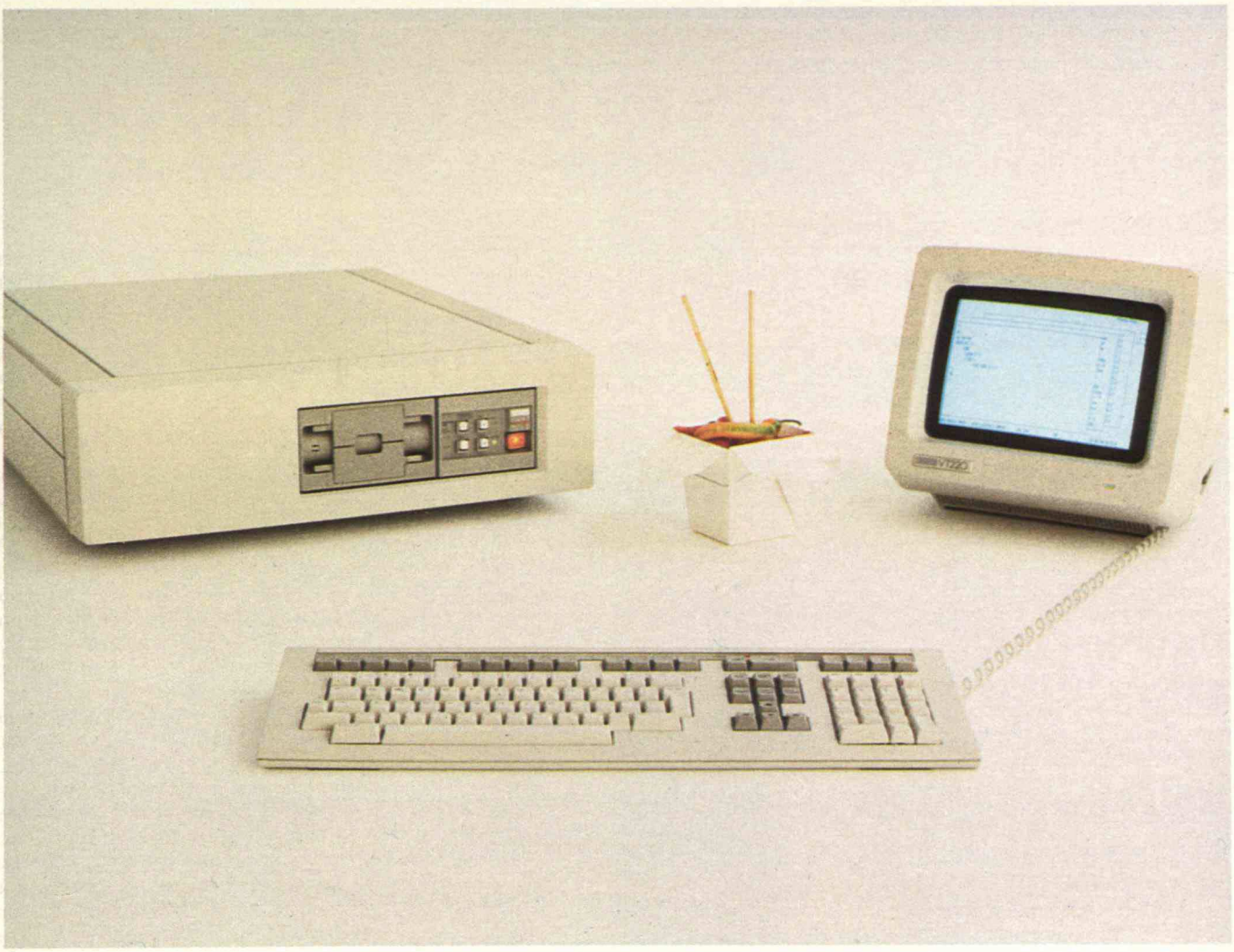
After studying management personnel in a large public utility, Lawrence concluded that young managers are more likely to be deeply involved in their work than older ones, but all use age and promotion frequency as measures for career development. Furthermore, says Lawrence, people who see themselves as "ahead of time" in their careers are more satisfied in their work than those who see themselves as on or behind time. Conclusion: lateral moves within organizations may be an important device for keeping managers happy when there are no vacancies at the top.

Lawrence is a graduate student in industrial relations in the Sloan School of Management at M.I.T., where Abraham is assistant professor. Medoff is associate professor of economics at Harvard. □

Condensed Electronics

A new way to update professional skills is being offered at M.I.T. to practicing engineers beginning this fall—a "postgraduate study program" in which material from regular M.I.T. one-semester courses is condensed into intensive presentations lasting just two weeks.

The first trial involves condensing "Introducing Electronics," the basic course in that field. Emphasis is on material developed within the last 10 to 15 years, says Professor Louis B. Braida. He hopes the benefits will be two-way—for industry updated skills for key professionals, and for M.I.T. improved academic-industrial interaction. □



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